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The Telephone Convention. THE Detroit meeting recently closed was a marked success. The papers and discussions will be read with interest by those who are practically engaged in that branch of electrical industry. But there was much, too, that is well worthy the notice of all electricians and the public generally. It was most evident that the telephonic fraternity are coming to look on the metallic circuit as less of a bug-a-boo than formerly. That class of service is steadily on the increase, and favorable opinions of it were freely expressed. In the general methods of exchange operation improvements are constantly being made in a quiet, unostentatious way, so that except for the material evidence of better service and occasional reports at these conventions the public hardly realizes what is being accomplished. We have all come to take the telephone so much as a matter of course that it is hard to appreciate how much has really been done. And yet when one deliberately marshals the reserves of his memory and compares the telephone operation of 10 years ago with the long-distance practice of to-day, he will understand that there has been a quiet but complete revolution.

Improving the Gas Engine. MR. SPERRY'S description of his new duplex gas engine details the result of some very ingenious improvements in that form of motor. The gas engine is a more efficient means of securing energy from fuel than even the best steam engine. In spite, however, of this theoretical advantage the mechanical difficulties to be met in utilizing the energy of an explosion to produce continuous rotary motion are so great that the gas engine has as yet occupied but a subordinate place. Mr. Sperry has devised a method of combining two single acting cylinders that obviates the great difficulty of lubrication at high temperatures that has stood in the way of double-acting gas engines in the past. In this plan the elaborate cycle of many of the present machines is replaced by an action that closely resembles the cycle of a steam engine. The double acting character of the machine tends to give a regular rotation at a uniform speed without the necessity of a heavy fly wheel. We shall be interested to see the progress made by this gas motor, and the success given by its theoretical advantages under the severe conditions of everyday use.

The Westinghouse Electric Railway. PERHAPS no electrical system ever was so thoroughly exploited with more of secrecy than the Westinghouse electric railway. Its managers have kept its details secret even from purchasers, and yet without models or even drawings have taken contract after contract, apparently solely on public faith in the mechanical resources and business integrity of the great company that has undertaken the work. We now have to chronicle the successful opening of the first Westinghouse road, in Lansing, Mich., and can fortunately present a cut of the motor car and a brief description of some of the features of the system. As will be seen, there are no radical innovations on our present approved methods of construction and operation, but the mechanical and electrical details seem to have been worked out with much care and to have united to produce a most gratifying success on this initial road. The ease of changing the armature or field coils will commend itself to every practical electrician as the lessened noise of the thoroughly lubricated gearing will meet the approbation of the general public. The system is more nearly an evolution along existing lines than first rumor had led electricians to suppose; but its high stage of development is attested by the result of the trial at Lansing, and the Westinghouse Company is certainly to be congratulated on its capital start in electric railway work.

Modern Electrical Theory. DURING the last three years there has been going on a steady change in the theoretical conceptions and treatment of electro-magnetic phenomena. It has been no violent revolution, upsetting all our established ideas of electricity and substituting new ones, but rather a gradual evolution of clearer views, simpler methods and more convincing proofs, from the somewhat chaotic mass of investigation that had accumulated. In this work Prof. Hertz has been foremost, and it is specially appropriate that he should undertake the working out of the new ideas to simplify and supplement the propositions laid down in the great treatise of Maxwell. We present this week the first portion of an excellent abstract of Prof. Hertz's recent paper in which he attempts a somewhat simple treatment of electro-dynamic phenomena. To electrical students we particularly commend it. The modern advances in electrical theory are very slow in creeping into the text books, and the various investigations on which they are founded are widely scattered in various scientific journals. Yet they must be carefully studied, for in the experiments of to-day we find the practice of to-morrow. The student is poorly equipped who neglects the splendid investigations that have been going on almost under his eyes and that will probably play an important part in the practical electricity of a decade hence. Follow up the work as it is being done, for it is only too easy to get behind the times, and once behind it is no easy matter to catch up again.

Music on Tap. THE devotees of that hopeless average of ultra-civilization depicted by Mr. Edward Bellamy may be pleased to learn, from an interview in our columns, that certain minor attributes of "Looking Backward" society, if a universal aggregate of office holders could be termed society, may be realized even in this barbarous age. Fancy turning on the music at will and listening for an hour to the splendid performance of a famous orchestra. The idea is most luxurious and attractive, fit ornament of a sybaritic age. And yet, if we look further, beyond the mere outline of the suggestion, there lies before us a vista of dreadful possibilities. For with the success of the first telephonic *musicale* association there will spring into being rival organizations the very names of which would make incipient deafness bliss. Imagine the awful devastation that could be wrought by "The Organ Grinders' Telephonic Mutual," with a drop-a-nickel-in-the-slot attachment. Fancy the horrors of having one's disposition wrecked by a "popular programme," headed by a memorial to the late McGinty. And what new terrors would be added to that Juggernaut of the metropolis, the boarding-house, when "Sweet Violets" and other appetite-destroying tunes could be turned loose at feeding time. Perish the thought! If the company that contemplates embarking in this shocking enterprise succeeds in overcoming the telephonic difficulties that infest its path, let it by all means be given an exclusive charter, for the probability of cut-rate competition and an orchestrion in every boarding-house is really too horrible for contemplation.

Corporate Organization. ONE of the most thoughtful and suggestive papers read at the Telephone convention dealt with a subject which, while not directly technical, may be studied with profit by many of our readers. Up to a certain point a corporation may be regarded as an aggregation of individual officers and stockholders. But as soon as the interests become extensive, the operations involved and the employés numerous, a thorough organization and distribution of authority is absolutely necessary to successful work. The great railway companies, with their armies of men scattered over a wide domain, have been quick to appreciate this necessity and prompt in action. The key-note of Mr. Hall's admirable paper is his very apt Biblical quotation, "No man can serve two masters." So long as each member of the complex body is directly responsible to one superior, and to one only, the maximum amount of work can be accomplished, but as soon as the lines of authority conflict and the various members begin to work at cross purposes there is trouble. Among electrical companies the recent reorganization of the immense Edison interests is an excellent example of a thorough business system, and sooner or later all the larger corporations that have not already a complete co-ordination of all the parts of the industrial machine will find reform necessary. Even small companies can, as Mr. Hall points out, derive great benefit from the introduction of system into their operation as into their bookkeeping. Those that do business anyhow, like the country storekeeper who foots up his accounts with chalk on the back of his cellar door, are liable to come to grief.

New Value of the Ohm. A DESPATCH published in another column brings the news that the British Association at its late meeting recommended the adoption of a new value for the ohm. It is eminently proper that such a suggestion should come from the organization that just a quarter of a century ago first placed the unit of electric resistance on a scientific basis. The exact determination of this unit in absolute measure involves experimental difficulties so formidable that it is little wonder the various results have not been more concordant. And yet the different values of the ohm obtained from time to time have been for practical purposes almost identical, for the extreme range of variation from the highest to the lowest figures is barely over two per cent. In the original experiments made by the British Association Committee in 1863 and 1864, certain discrepancies were observed and sources of error were found so that it soon became evident that the "B. A. unit" had been given a value slightly too small. No general formal action was taken, however, toward the adoption of a more exact value until 1881, when the International Congress of Electricians met in Paris. At that meeting, which settled our present system of electrical units, it became clear that the ohm ought to be redetermined, and an international commission undertook the work. As a result of this, when the International Conference assembled in 1884, there was a rich harvest of new experimental results. It had previously been determined that the ohm should be expressed in terms of a column of mercury one square millimeter in section and at 0° C. The old B. A. unit equalled such a standard column 104.83 c. m. in length. Of the new values most slightly exceeded 106 c. m. They had been found by six methods, and in view of the differences existing between them it was decided that the legal ohm should equal 106 c. m. of the standard mercury column. Nevertheless the results from the preferable methods of experiment indicated about 106.2 c. m. as a more probable length, and as most of the sources of error tend in the same direction, a still higher value was probable. In the deliberate review of the various determinations it has become apparent that the ohm assumed in 1884 should be revised, and accordingly the present action has been taken. 106.3 c. m. is the proposed length of the equivalent mercury column, and this revision is warranted by the results of Glazebrook, 106.29; Mascart, De Nerville and Benoit, 106.30; Rowland and Kimball, 106.31; and Rowland, Kimball, and Duncan, 106.29. The proposed B. A. ohm is, then, 1.0028 times the legal ohm of 1884, and consequently resistances measured in legal ohms are numerically too great by a trifle less than three-tenths of one per cent. This difference is too small to be of much practical account, but for absolute measurements it may be convenient to note that resistance coils of german silver will be standard, in new ohms, 6.4° C. above their present standard temperatures. We trust the new value recommended will be generally adopted, as it is undoubtedly more nearly exact than the present legal ohm.

ELECTRICITY AT THE BRITISH ASSOCIATION.

Special Cable Despatch to The Electrical World.

The Leeds meeting of the British Association for the Advancement of Science, which had been in session since Sept. 3, closed on Wednesday, Sept. 10. The attendance was somewhat smaller than usual. Most of the electrical papers were of a theoretical rather than practical character. By far the most interesting of them was that by Prof. J. A. Ewing, F. R. S., on the molecular theory of induced magnetism. The speaker explained nearly all magnetic phenomena by magnetic forces exerted by molecular magnets, and his paper was received with the greatest enthusiasm. The question of the proper value of the ohm was also taken up and it was finally recommended that the ohm be defined by the resistance of a mercury column of one square m. m. section, 106.3 centimetres long and at 0 degrees C., instead of the column 106 centimetres long adopted at the International Conference in 1884. Professors Rowland and Barker undertook to refer this recommendation to the United States Government, while M. Mascart and Mr. Preece, respectively, will present it to the French and English authorities.

NEW BOOKS.

Leçons sur L'Electricite, by Eric Gerard. Vol. II., pp. 406; illustrations 142. Gauthier Villars. Paris, 1890.

It is a rather formidable task to write a book like that which M. Gerard has so successfully attempted, covering the modern industrial applications of electricity. Such a work must necessarily be incomplete, for the amount of matter is so great that it cannot be compressed into contracted limits. Nor in a book of moderate size is it possible even to give a complete account of the principal electrical systems and methods. Nevertheless, M. Gerard has accomplished the difficult work of writing a clear, correct and very readable book, covering a wide range of practical subjects and describing the various forms of electrical apparatus and their principal commercial applications with all the fullness that could be desired in so general a treatise. Taken altogether it is a very meritorious book on practical electricity, avoiding as it does, on the one hand, too great brevity of description, and on the other hand, that frequent sin of popular writers, statements that are loose rather than popular, and inexact rather than simple.

The present work is intended to give a general account of the applications of electrical energy with which we have to deal day by day. It opens with a brief discussion of the methods employed in the distribution of electrical energy, giving in rather simple form the theoretical principles, a discussion of "Thomson's Rule" and Forbes' excellent tables for simplifying computation. The general methods employed in both aerial and underground lines are described with more exactness than usual in books of the kind; and especially the subject of feeders, their function and arrangement, is brought to the attention of the electrical student in a way that is hard to find elsewhere.

In his discussion of the electric motor, M. Gerard might have gone more into detail with advantage. His treatment of the subject is good, but somewhat insufficient, particularly in the matter of the alternating current motor, which, although it has not yet found an important commercial place, is certainly of sufficient interest to deserve a description more in detail than our author has seen fit to give.

The electrical tranmission of energy is represented by a brief theoretical discussion and a rather general account of some of the well known instances of transmission on a large scale on the Continent. It will be news to most of our countrymen to hear that the water power of Niagara has as yet been put to any practical use on a large scale. M. Gerard is thoroughly up to the times in most branches of the subject, but we fear that in this particular instance he is some years in advance of present developments.

Of course, in the general treatment of distribution, the description of distribution by transformers and storage batteries necessarily finds a place. Both methods, however, are but briefly discussed. It is a curious thing that the practical aspects of alternating current distribution, and the actual methods employed in operating and caring for alternating apparatus, are very inadequately described in the books now before the public. It is very difficult to find proper descriptions of even the most familiar alternating apparatus, and our author is, therefore, not at all behind his contemporaries, even although he has devoted comparatively little space to this important subject.

A brief account of two or three common forms of meter closes the chapter devoted to general problems of distribution, and then a practical account of several well known methods of underground distribution ends the discussion of this phase of practical electricity.

One of the most satisfactory chapters to be found in the treatise, is that on electrical traction, a phase of electrical distribution which has been much neglected in foreign books. The author seems to have followed up the subject very closely and carefully, and is thoroughly alert to all the recent theoretical and practical developments. In this respect, the work is more closely up to date than any other; and we do not know of any book in English where the important question of the electric railroad is handled with the same degree of completeness.

Then in succession the subjects of electric light (both arc and incandescent), photometry and central stations, are taken up, and typical methods and forms of apparatus receive a very satisfactory description.

Brief accounts of electro-metallurgy, electric-welding, and allied processes then close what, on the whole, we must consider a very useful contribution to electrical literature.

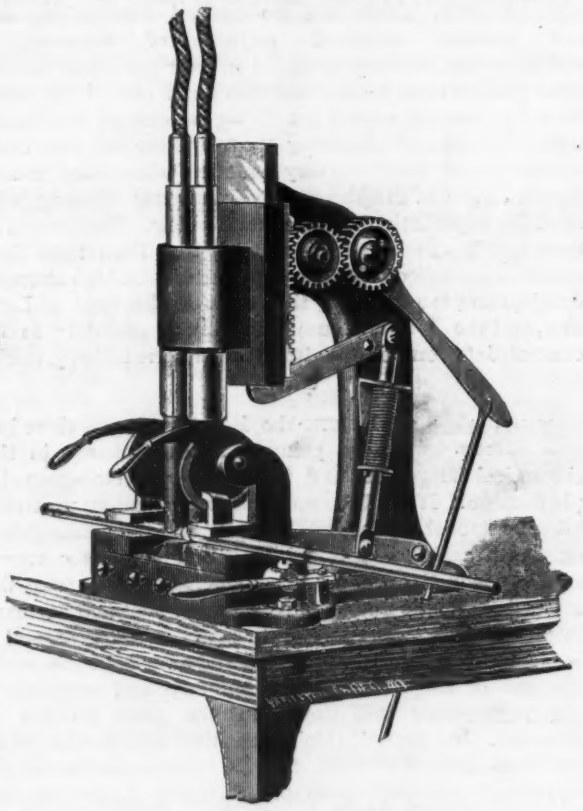
The book is an admirable one, and in most particulars is thoroughly up to daet. Here and there, of course, the description of important details is too brief for the best results, but this is a necessary consequence of compressing an enormous subject into a small space. The errors—although we have to remark but few—are comparatively unimportant, and the book can be cordially commended to such students of electricity as have the necessary knowledge of French.

Practical Treatise on Injectors. By George N. Nissenson. Paper, pp. 74, illustrations 41. New York. The author, 1890. 50 cents.

This little pamphlet comprises a general description of forms of injectors most generally used in steam plants. It is written in simple, clear language, from the standpoint of a practical engineer, and should prove useful to any one who chances to have the charge of boilers fitted with injectors. The illustrations give a very good idea of most of the forms of injector in use in this country; and the directions for use are brief and explicit. It is confessedly a practical book for working engineers.

A New Method of Electric Welding.

In the incandescent method of electric welding the time required to make a weld is a very important factor, since the shorter the time taken to make a weld the greater the power used. If a weld be made too rapidly there is liability of burning the ends in contact, while if the operation is conducted too slowly the machine and welding clamps are overheated, and there is a consequent loss of energy by radiation of heat.



Coffin's Incandescent Welder.

Another important matter is the distance between the welding clamps and the extent of material exposed to the welding circuit. If there is too great a projection beyond clamps a longer length of bar will be heated than is requisite, and there will be more power lost from radiation. With a shorter projection beyond the clamps the resistance through the work is decreased and less power would be used, but upon the pieces becoming heated the clamps heat also, and an increased resistance is thus thrown in the circuit. To obviate this heating of the clamps it is customary to cool them by having them constructed with water circulating through them. A method which admits of very diverse application, and in which the distance between the clamps and the extent of material exposed is immaterial, has been perfected by Chas. L. Coffin, of Detroit, Mich.

In the apparatus shown in the cut the rods are secured in the eccentric clamps with their ends resting upon the conductor block, but not in contact with each other; the conductor heads are brought down upon the extremity of the rods in such manner that the current traverses the material transversely, heating only the extreme ends of each bar. When the tips of the bars have reached a welding heat the treadle may be released. This raises the conductor heads, and a slight pressure with the hand lever, as shown at the right of the cut, completes the weld. For ring, hoop, and tire welding the tool is provided with movable interchangeable clamp blocks and followers and accompanying conductor blocks and heads, so that the work may be placed vertically, horizontally, or in any desired position.

This method of incandescent welding possesses many important features. As the extremities of the material operated upon are independently heated it becomes an easy matter to weld together two articles of different cross section, since they may both be brought to a welding heat simultaneously by adjusting the requisite amount of current to each.

This is considered to be a decided improvement over former methods of incandescent welding, where trouble has generally been experienced in attempting the welding of articles of different cross section, on account of the extremity of the larger piece heating more slowly than the piece of smaller cross section, which reaches a welding heat much sooner than the former, and as in most instances the welding temperature is but a few degrees lower than the temperature of fusion, the continued exposure of the smaller article to the current necessary to raise the larger piece to a welding heat often causes fusion and dissipation of the extremity of the smaller piece. The same difficulty has been experienced in welding articles of different normal resistance, or of articles reaching a welding heat at different temperatures.

Since the bar heats at the points of contact on account of the high resistance, and as the heat of the bar increases the resistance increases, and consequently the heating effect of the current, it will be seen that this method effects a close localization of the heated portion of the bar and admits of an arrangement of the apparatus which permits the workman to have free access to the work. In operating this method the potential may vary from one volt to 20 or 30 volts in special cases, and from 500 to 25,000 ampères or more. A light hammering of the weld while finishing improves the strength and is advisable in all cases of steel welding. The time required for welding one-inch iron under ordinary conditions of working is about one-half minute, with an expenditure of eight h. p.

With this method almost all combinations can be welded. Iron, steel, tool steel, wrought iron, copper and brass are welded without difficulty, or any previous experience being required. Rod, bar, sheet and wire welding are readily accomplished, while for rings, hoops and tires it is said to be an excellent method, as no accessory apparatus or appliance is required to prevent the short circuiting of the current around the work.

The following welds have been successfully made by this system; the most difficult alloy to weld being tungsten steel.

	ALLOYS.	
Bessemer steel.	Gun metal.	Mitis casting.
Chromium steel.	Type metal.	Phosphor bronze.
Tungsten steel.	Solder.	Cowles patent aluminum bronze.
Cast steel.	Fuse metals.	Silicon bronze.
Tool steel.	Gold coin.	Japan bronze.
Brass.	Silver coin.	
	METALS.	
Wrought iron.	Platinum.	Gold.
Cast iron.	Copper.	Tin.
Malleable iron.	Manganese.	Iridium.
Bismuth.	Cobalt.	Zinc.
Aluminum.	Nickel.	Lead.
Magnesium.	Silver.	Antimony.
	COMBINATIONS.	
Cast iron to wrought iron.	Silver to copper.	Gold to copper.
Cast steel to wrought iron.	Silver to gold.	Platinum to gold.
Cast iron to brass.	German silver to copper.	Platinum to silver.
Brass to copper.	German silver to gold.	Lead to tin.
Brass to wrought iron.	Zinc to tin.	Platinum to iridium.
Copper to wrought iron.	Brass to tin.	Platinum to silver coin.
Steel to wrought iron.	Brass to German silver.	Iridium to gold.

The oxidation of the heated portion of the weld is very rapid in the case of many metals, and with a view to the removal of this objectionable feature Mr. Coffin has devised two methods of electric metal working in which all oxidation or scaling is avoided, namely, surrounding the heated portion with a non-oxidizing medium or performing the welding operation in a vacuum.

In the first instance the non-oxidizing medium may be a hydrocarbon vapor or gas with which the weld is surrounded. It has been found that oxidation is impossible, and with a sufficient exposure to the gas it is possible to harden the exposed portion of the iron.

Where the weld is performed in a vacuum some interesting features have been discovered. A brightly polished piece of metal may be welded in a vacuum without injury to the polish, so perfect is the manipulation. A stress or strain put upon the weld increases to a very great extent the heating effect of the current, while if the material is fractured or broken while in the vacuum and the pieces be immediately joined at the first fracture the weld will form at a low red heat.

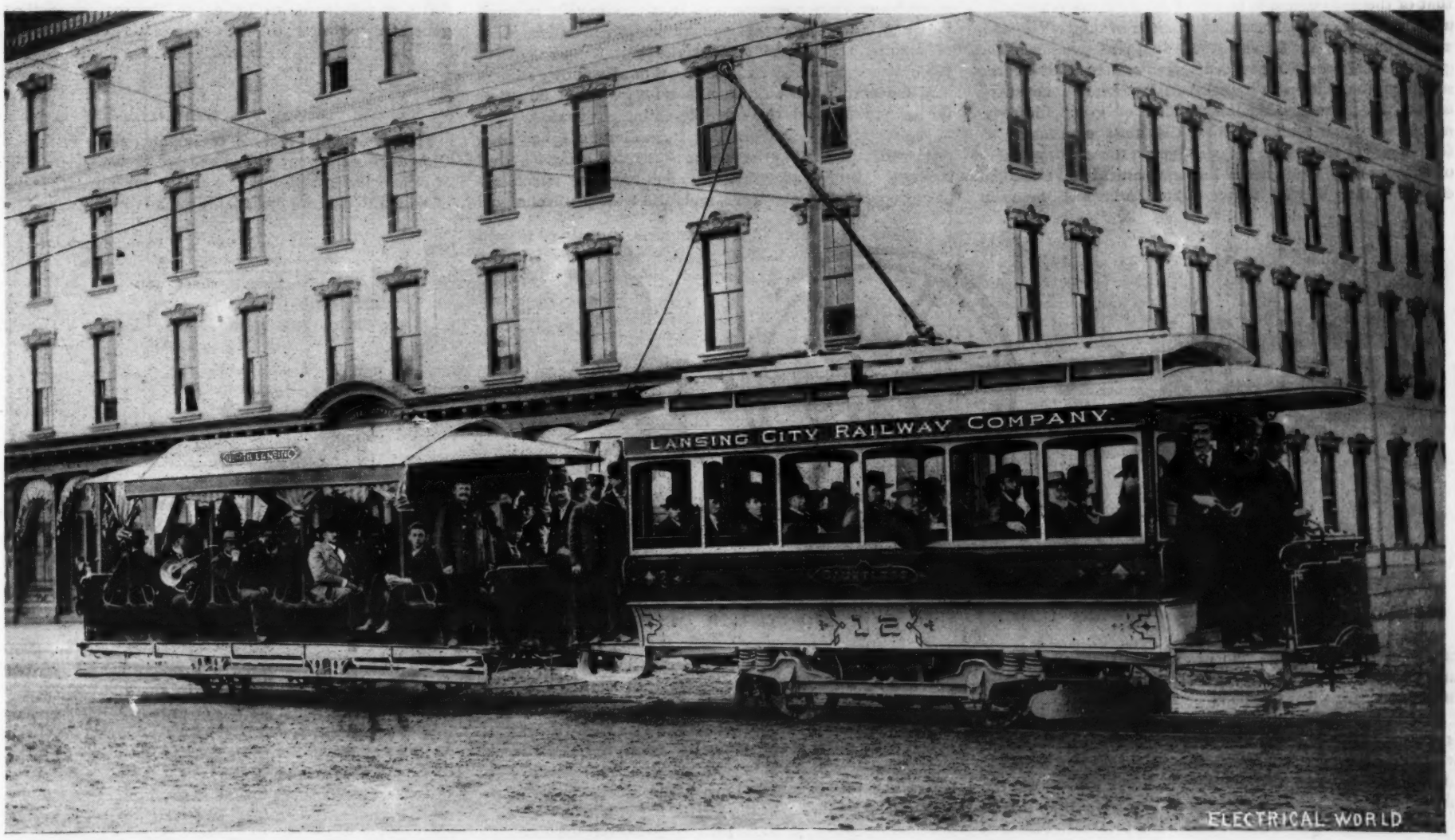
For rapid working as in ordinary workshop operations, a high vacuum is seldom attempted. With a low vacuum of one-twelfth, the energy required to weld an iron bar is one-half that required to weld the same bar in air; with a vacuum of one-half, the energy required is one-fifth of that required to weld the bar in air; while with a high vacuum, but one-tenth the energy is necessary. Thus with a vacuum of one-tenth or one-twelfth, which is very easily and rapidly obtained in workshop operations by simple means, it is seen that 50 per cent. of the energy is saved in making the weld. Perhaps no better illustration can be given of the enormous loss of energy due to radiation of heat in welding operations. By a very simple device the work is arranged so that a high rarefication or vacuum surrounds the weld, and this device renders the vacuum process applicable to all systems of electric welding.

The Westinghouse Electric Railway.

The first Westinghouse electric road was successfully tested in Lansing, Mich., Aug. 27, and since that date has run continuously and has given great satisfaction to the Lansing City Railway Company and to the citizens. The initial trip was made without a single hitch or difficulty of any kind, and since then three motor cars, each drawing one or two trailers, have been in regular use. The owners of the road insisted on a trial being made before a single switch was in place, the ground connections properly made or any electrical work done at the car barns. Yet, so well were they pleased with the operation of the motor car that the horses were sent out to pasture the next morning, and the road has been operated electrically since. The length of track of the Lansing City Railway Company is about six miles. The roadbed is the same which has been used for many years, the rails being of the old flat type, that do not conform very readily to the flanges of the wheels, and will consequently be replaced later with a heavier and better rail. On a portion of the line leading to the Fair Grounds the road is really a surface line, where the ties are placed six feet apart and very insufficiently ballasted. Notwithstanding these drawbacks, the serious character of which anybody familiar with electric railway operation will readily see, the cars have worked admirably.

There are but two sets of coils on the field magnets, and, in addition to these, starting resistances are employed. It will thus be seen that the general method of grading the speed is a combination of that used in the Sprague and Thomson-Houston systems—the initial resistance doing away with unnecessary strain on the motors at the start, and a still further gradation of power being supplied by the arrangement of coils. On starting the car, the switch handle is slowly moved from the first up to the fifth notch on the switch dial. This action cuts out successively the three resistance coils and throws into action successively the two field coils. This arrangement starts the car smoothly and easily, without danger of injuring the motors.

The motors are suspended in iron cases to protect them from dirt and moisture, the frames being, as usual, swung from the axle at one end and resting on compression springs at the other. The gear wheels which convey the power to the axle are of cut steel, with five-inch faces, and run incased in oil-tight castings partially filled with oil, thus giving a very elaborate lubrication and very much lessening the noise, which is too familiar a concomitant of the electric street car. The motors are adapted to reach a speed as high as 20 miles per hour, and their operation is exceedingly smooth and regular. The brushes are carried on hard wood rocker arms, supported by vulcanized fiber



THE WESTINGHOUSE ELECTRIC RAILWAY AT LANSING, MICH.

A large fair has been in progress in Lansing, and during the crowded week a motor car and trailer often carried over 250 passengers up a long grade of nearly five per cent., with a curve at the start. The line is single track with single turn-outs. As regards the system itself, it is, as is already clearly understood, a single trolley system, in its general appearance—as is quite evident from our cut—closely resembling the systems now in use. The trolley wire is supplied from a heavy insulated feed wire running along the pole line, and it is noticeable that the overhead construction is of the most solid and workmanlike character.

The trolley used is of the same general character and appearance as those with which the public is already familiar. The motor cars are models of their kind, were manufactured by the Ellis Car Company, of Amesbury, Mass., and are mounted on Hubbard trucks with heavily cushioned springs. The interiors are finished in mahogany, with cushioned seats, plate glass mirrors, and the customary incandescent lights. It is possible that they may be electrically heated later in the season. The motors themselves are, as in other systems, two in number, each of 15 h.p., and in general arrangement are quite similar to the more approved forms now in use. A special feature of their construction is the ease with which the armature can be removed, the field magnets being hinged so that by withdrawing fastening bolts they open out. This enables repairs to be made with a quickness and ease which will be appreciated by all who have had occasion to replace field coils or armatures in the contracted space under a car,

bushings around the holders. The power station is at present a temporary affair, equipped with a Westinghouse generator of the well known United States pattern and 80 h. p. capacity. This is belted to a compound condensing engine of 150 h. p. built by the Lansing Iron and Engine Works. The road is owned by Mr. H. L. Hollister and M. D. Skinner, and the work of construction has been done under the personal supervision of Messrs. E. W. Gray and A. H. Knott of the Westinghouse Electric and Manufacturing Company.

The Cheapest Electric Light Supply in Europe.

An English contemporary says that the town with the cheapest public supply of electric light in Europe is Trente, in Austria. The station is owned by the municipality, and has at its disposal a large motive force from a waterfall under excellent conditions. The light is furnished to private consumers at the rate of 50 kreutzers (about 20 cts.) per year per candle power, no regulation being made as to the number of hours. To put the electric light within reach of the poorer inhabitants, the house wiring, done by the town, may be paid for in annual payments. The station also supplies motive power. A flour mill and a spinning mill have already adopted it, and it is expected to spread amongst the small local industries. The price of this is also extremely low—40 florins ($16) per horse power per year.

Extension and Improvement of Telephone Service.

While in Detroit at the Telephone Convention last week Mr. E. J. Hall, Jr., vice-president of the American Telegraph and Telephone Company, made the following remarks upon this interesting subject: "As to the solution of submarine 'phoning, that has already been accomplished over a line of about 10 miles, and with very good results, so you see that the accomplishment of any given distance is only a matter of study and application. It is to be taken into consideration that at the present time a great difficulty is met with in submarine 'phoning, in consequence of the jarring of the waves, a sort of vibration being occasioned and kept up by the forces that cause commotion in the deep.

"I want to say a word about long distance telephoning on land. To-day no man can say what will be the limit of long distance telephoning on land. We not even know what the present limit is, because it has never been reached. Only the day before I came here I telephoned from Buffalo to Washington with perfect results, and could distinguish the voice of the party who was on the other end of the line with as much ease as though he were but a few miles distant. I know not how much further I might have heard the voice distinctly, provided I had the facilities at hand. As I before remarked, no man can tell what a day may bring forth in the way of telephone improvements. Ten years ago every telephone man declared, and honestly, that the wires could not be operated in a subterranean conduit; to-day ingenuity has contrived means to do this, and in large cities the companies prefer conduits in some places.

"But outside of the mere perfection of the working of the commercial telephone service, a very great improvement is being wrought in what I might call æsthetic uses of the instrument. You already know that the instrument is now used for the transmission of sermons to the houses of persons who for some reason are prevented from attending the services. This is done well enough, and by the attachment of a trumpet-like arrangement, the voice of the speaker is thrown out into the room, in very much the same way that the natural voice is dispersed. The change in the voice is unappreciable. But more wonderful still, is a scheme which we now have on foot, which looks to providing music on tap at certain times every day, especially at meal times. The scheme is to have a fine band perform the choicest music, gather up the sound waves, and distribute them to any number of subscribers. Thus a family, club or hotel may be regaled with the choicest airs from the favorite operas while enjoying the evening meal, and the effect will be as real and as enjoyable as though the performers were actually present in the apartment. We have perfected the distribution, and have over a hundred subscribers, or rather persons who have certified to their anxiety to be subscribers, and only await the perfecting of methods for overcoming certain modifications of tone and timbre that now occur.

For instance, at present the telephone does not distinguish between notes of a harp and a piano; and it does not deliver the notes of reed, wood and brass instruments with the same faithfulness. Thus the cornets are apt to have an undue penetration and preponderance. When we have overcome this difficulty we shall be prepared to furnish music on tap."

Duplex Gas Engines.

BY ELMER A. SPERRY.

It was Prof. Fleeming Jenkin who first gave to the world the mathematical demonstration of the increased economy attending triple and quadruple expansion in the steam engine. Prof. Thurston, in this country, in his recent paper on steam engines for electric lighting,* has pointed out the extremely high theoretical attainment of the latest forms. He says that in fact these have now attained "so perfect a condition that the range for further improvement is probably very narrow, and the gain still to be made must come slowly and painfully." The first named eminent authority has further made the statement that "the actual achievement of the steam engine has nearly reached the limit of the possible."

The efficiency of the steam engine when taken as a measure of the recovery of power from the total power-equivalent of the heat employed, following the most improved methods, is only about 10 per cent. when large units of power are considered. To compare this performance with that of the gas engine, it is but fair that we take equal units in either case. In the comparison of the two motors as heat engines, size for size, the actual performance of the gas engine is over 200 per cent. better than that of the steam engine, with a vast unexplored region beyond in the case of the gas engine, giving promise of great improvement and higher economy than the most excellent performance yet recorded. In considering the great problem of transforming heat energy into mechanical and electrical energy, it may be well to investigate the laws of operation and working of a system that has already realized so much in the direct line of transformation of heat into mechanical motion.

The gas engine is a hot air engine in which the air as it is drawn into the cylinders is charged with a substance which may at the proper moment yield the heat required to increase its bulk, the confining of which develops the pressures utilized in moving the piston. This increase of bulk on ignition, and the corresponding pressure of the air, is from four to five times. Thus if the air or mixture in the cylinder at the time of ignition is 40 pounds, the pressure resulting from ignition is about 200 pounds. The ignition does not cause an explosion, as is usually supposed, but on the contrary the inflammation goes forward until a certain pressure and temperature is reached, and at this point is arrested, and further inflammation is developed as the piston goes forward and the pressure thereby tends to decrease. The writer has seen cards from gas engines in which constant pressure was developed throughout nearly the entire stroke. This is especially the case with lean mixtures, or below 11½ to one of ordinary illuminating coal gas.

This system of transferring the furnace, wherein the energy is primarily developed, into the cylinder of the engine itself and there utilizing directly the benefits of combustion, is undoubtedly the greatest step in advance of the present half century in the direction of high economy and efficiency. There is no doubt but that the engine of the future is to have its furnace in its cylinder, thereby eliminating the gigantic waste attending latent heat which is encountered in the case of steam. The high performance of 1.4 pounds of coal per horse power per hour in a 10 horse power engine compares favorably with from 7 to 12 in the steam plant of equal size.

This being true the question is asked, "Why are not gas engines more sought and employed for ordinary power purposes?" The answer to this question can only be found by a study of the performance of the present gas engine, noticing the difficulties encountered and the limited application to the more exacting power consumers, and the devices resorted to in the attempt to overcome some of these difficulties. The greatest evil of the present method and cycle of operation in the gas engine is the want of uniformity of speed in the power developed. This is owing to the fact that usually but one out of four, frequently one out of eight, of the strokes or units of power is available for producing effective results. The others are not only non-productive, but actually consume the energy developed in the one. It is true that engines have been produced that make every other stroke effective; but this system at best produces irregularity that renders it indifferent for driving more delicate machinery, especially electrical generators for lighting purposes. It is true that dynamos may be driven by existing engines to supply storage batteries with some degree of success. But where direct illumination is required the noticeable irregularity and throbbing prohibit general adoption.

The gas engine of to-day undoubtedly stands in the same position as the steam engine in 1860 when Charles T. Porter first proposed to develop double or triple the power from the same weight of material for the same weight of engine by increasing the number of its power producing elements per minute from 50 strokes, as was the practice, to 250; or to follow history in steam engineering still further back in the days of Newcomb and Crawley, when all cylinders were single acting and a multiplication of cylinders was required to increase the number of power strokes.

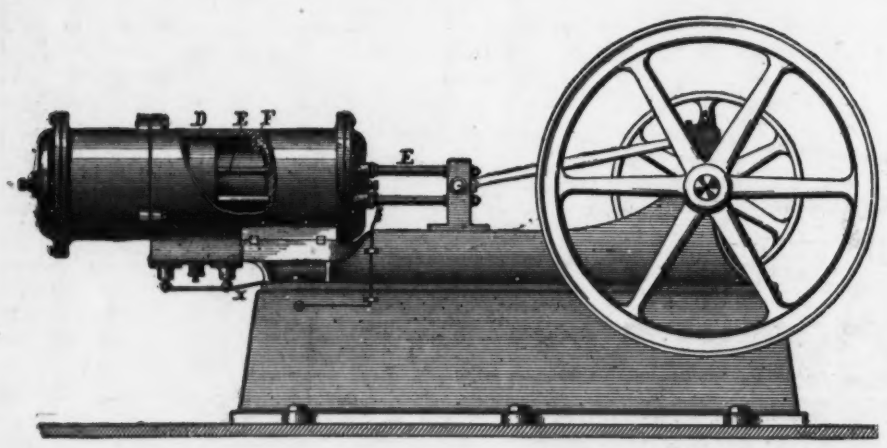
The commercial gas engine of to-day has a single acting cylinder. The difficulty of packing against the high temperatures has been found, and probably will remain, insurmountable. French engineers have sought in vain, through long continued and expensive experiments, to find methods of packing a piston rod against the high temperatures of the cylinder, and thus to produce a double acting engine. The American engineers have heretofore tried, but thus far have failed, to devise a double acting gas engine.

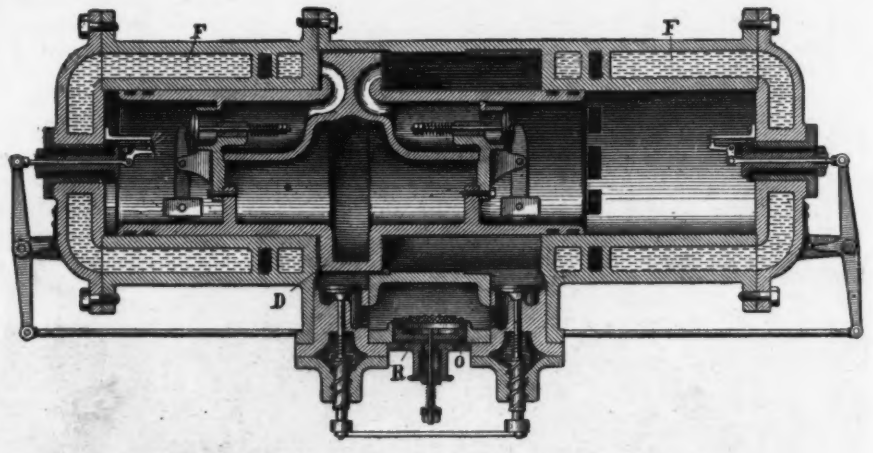
The most successful practice in gas engines has been followed in producing the engine illustrated herewith; that is, single acting combustion cylinders are used which are placed opposite to each other, and form a single mechanical element. Midway between them is a cylinder of larger bore performing the office of a pump for transferring the mixtures to their proper destination before combustion. The compound piston, which reciprocates in these three cylinders, is also a single mechanical element, the two ends being of similar size, forming plunger pistons operating in the combustion cylinders, in the middle of which is an annular enlargement *D* which fits the larger bore of the pump cylinder. The differential area so produced between the combustion piston and the pump cylinder is the area which is available for transferring the gases, and forms the piston area of the pump cylinder. It is to this element, namely the annular shaped pump piston, that the main piston rods *E*, two upon each side, are attached, as may be seen in Fig. 1, thereby eliminating the necessity of packing against the high temperatures. The only packing required in the piston rods is against the low pressures of the cold mixture within the pump. It will be seen by Fig. 2 that the two combustion cylinders are at opposite ends of the compound cylinder. The water jackets are shown at *F*. Along parallel to the front cylinder are the cored passages in which the two piston rods *E*, connecting with the cross head, reciprocate (see Fig. 1). The packing glands are required to pack only against the small pressures of the gases in the pump cylinder. This pressure is so slight as to be wholly disregarded.

The law of operation or cycle of the engine is as follows: The pump is double acting and is provided at either end with an induction valve, below which is a screw, by turning which the seating of the induction valve may be varied. This varies the pressure within the pump, and, therefore, the amount of mixture transferred into the combustion cylinder previous to ignition. The ignition is performed by the electric spark, the two igniters being coupled in multiple arc. The mixing device is peculiar, extremely simple, and consists of a valve *O* covering both gas and air passages in a perforated plate. This valve is so large as to nearly fill the circular space in which it is contained, leaving only a very narrow circular slot at its periphery. The gas and and air as they are drawn through this narrow slot are given a very high velocity by the suction of the pump at either end. A wire gauze diaphragm *R* stands immediately in front of this passage and completely breaks up the rushing gases as they emerge from the slot. These as they reunite form a most intimate and complete mixture. Experiment has shown that this mixture attains almost theoretical perfection, aiding materially in the perfection of combustion and economy attending the operation of the engine. The compression of the engine is from 35 to 45 pounds before ignition, when the engine is working near its capacity, and from this figure down to atmospheric compression when working less than its rated capacity. A governor on the axle is connected by the rod *X* to the two screws beneath the induction valves, and thereby automatic regulation is obtained, which is found in practice to hold the engine within 3 per cent. from full load to zero.

The actual efficiency of the engine is very high, being from 19 to 21 cubic feet per horse power. The perfect uniformity of speed is owing to the fact that every stroke is effective, and a comparatively small weight of engine is required to the horse power. Chief among its merits is its low cost of manufacture. A 13 h. p. engine of this make weighs only about 1,900 pounds and requires but a small fly wheel, and for purposes of driving dynamos the fly wheel may be used for band wheel, about the same practice being followed as in steam engineering in determining the weight of these elements.

Mechanical and electrical engineers will look upon this invention with unusual interest, owing to the fact of its being the first system of construction which rendered the double acting gas engine feasible, and a very available form of prime mover added to the present methods of generating power.





FIGS. 1 AND 2.—SIDE VIEW AND SECTION OF SPERRY'S DUPLEX GAS ENGINE.

* See The Electrical World, Aug. 9, 1890.

Progress in Electric Mining Operations.

*BY R. M. HAZELTINE.

The phenomenal feature of advancement in mining in Ohio during the year just closed has been the introduction of electricity as a motive power in our mines, by means of which to reclaim our coal. Its adaptability and many commendable features have awakened a great interest among those who are engaged in the industry. The department has been in receipt of many inquiries as to the progress that has been made, from operators in our own as well as those of our sister States. It is not the province of the department to criticise any feature of the different systems in use or any particular electrical plant that has been erected in the State, neither is it the desire to enlarge upon those which it can be truthfully said are doing economical work at the close of the year. That its application has been successful in each instance to the degree that its advocates desired can hardly be claimed. A single branch which failed when tested at one mine has been successfully applied in another, and this fact may account for many conflicting reports in mining circles as to the degree of proficiency to which it had arrived in the endeavor to apply this new power to man's use in this great branch of the industry in the State. While the practical application of electricity, as yet attained, is far short of the claims which are made for it by those interested in the manufacture of various machines so essential in the mining industry, sufficient proof has already been furnished to demonstrate to any practical person, who has given the matter any attention, that the economical production of coal by the use of electricity in many portions of the State is only a matter of a very short time. As the subject is a new one to many of those who are interested in mining in the State, it may not be out of place to describe, as briefly as possible, the progress made by those who have been foremost in the introduction of it in our mines.

The first installation of electric mining machinery in the State was undertaken by the Shawnee & Ironpoint Coal and Iron Company at their Whip-poor-will mine at Shawnee, in Perry county, under Mr. Eli Hull, the general manager. The contract for the steam plant was given to the Taylor Manufacturing Company, of Chambersburg, Pa., and the contract for the electrical machinery, consisting of a 40 h. p. dynamo, an 8 h. p. exciter and a 15 h. p. motor, also the line conductors, etc., with the exception of the car frame, the gearing and regulation, was given to Messrs.

* Abstract of Report as Inspector of Mines. Cuts due to the courtesy of the *Black Diamond*.

Bidwell & Kimball, of Chicago, on Aug. 5, 1888. The erection of the line conductors and the work of fitting the motor to the car was at first under the supervision of Mr. Bidwell.

During that time the plan adopted was to carry the electric current by means of two channel iron conductors, each of which were placed just inside of the rails of 3 × 5 stringers to which they were securely fastened; the stringers were bolted to the ties; this left the conductors about four inches above the surface of the ground. The reason, says one of the contractors, for placing the conductors in this unusual position was, in the first place, to put them where the miners would be the least likely to come in contact with them, and in the second place to make the system conform as nearly as seemed practicable to the so-called Bidwell conduit system for street railways. The fact that no similar electric conduit, even when installed with the greatest care and expense in the paved streets of the cities, had been more than partially successful did not deter them from the very crudest repetition of the same experiment at a coal mine. The motor car was purchased at Barnesville and was entirely of wood, except the wheels and axles, and was little better adapted for the work than an ordinary bank car. With this car weighing less than 3,000 pounds the plan proposed was to draw a train of 10 empty bank cars up an inclined plane 800 feet in length, having a uniform grade of eight feet per hundred. The machinery and conductors having been put in place at a great expense, the contractors directed the first trial of the motor car on Dec. 23, 1888, when it was found to not have sufficient traction to even move its own weight on the incline. New and unforeseen difficulties presented, owing to the position of the channel iron conductors, involving mechanical difficulties in switches and trolleys that seemed insurmountable, and the plan proposed to haul by means of the motor on the plane was abandoned. About this time Mr. Bidwell severed his connection with the plant, and Mr. Kimball assumed the responsibility of entirely changing the plan to that of an overhead system which, with the assistance of Mr. D. M. Osyer, of Newark, was successfully accomplished. In this the same channel irons were utilized. This change was completed on Jan. 20, 1889, involving a delay of about three weeks, but when completed by the aid of a new trolley having a flexible connection between it and the car, the motor would haul six loaded cars in any portion of the mine, except at one point where the grade was from 5 to 6 per cent. against the load.

After six weeks' use it was found that the chain gearing in use on the motor car was not suitable for the work and that the car was too weak as well as too light and that the trolley as first devised was found in actual use

FIG. 1.—JEFFREY MINING MOTOR WITH GAS PIPE CONDUCTOR.

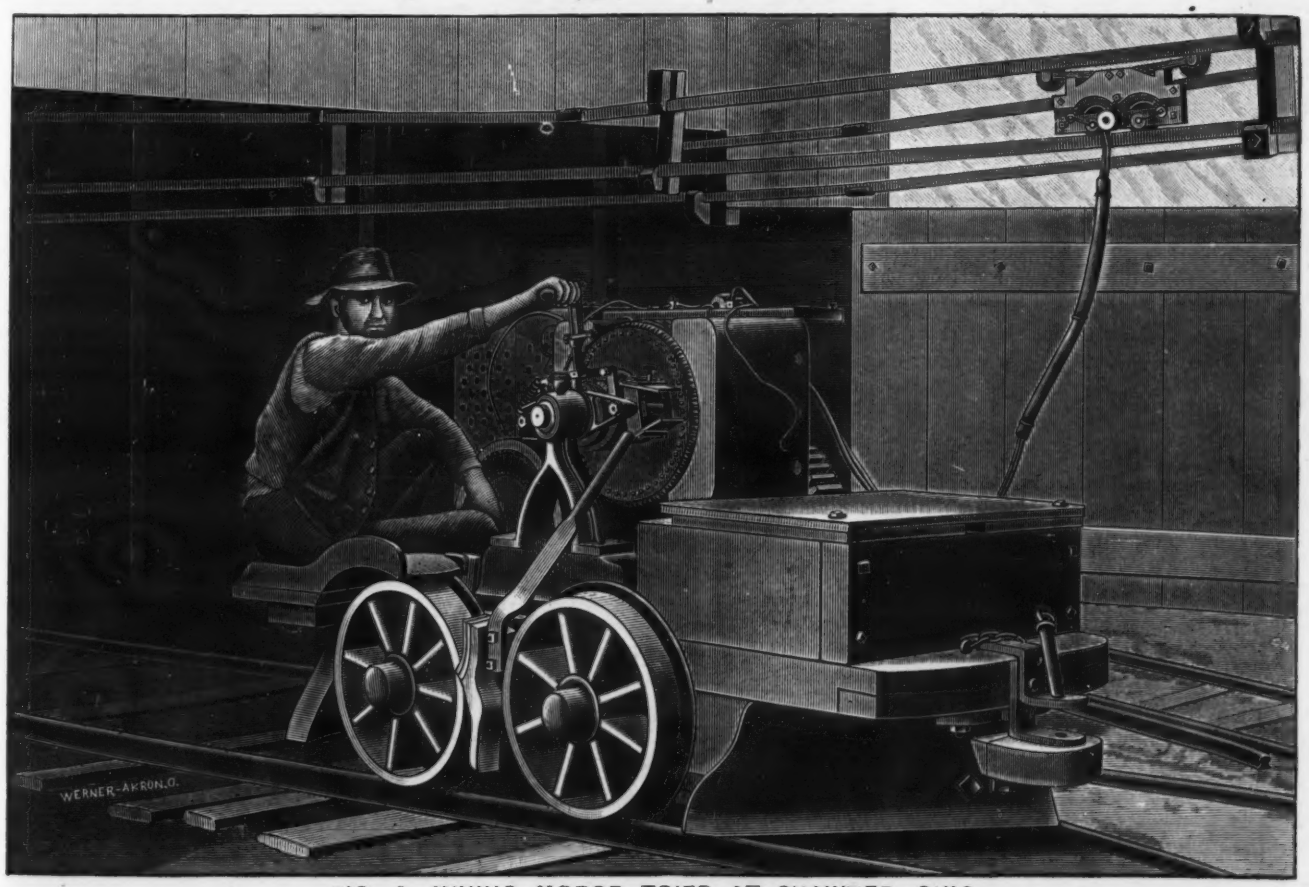


FIG. 2.—MINING MOTOR TRIED AT SHAWNEE, OHIO.

to be also too weak. A new car designed to overcome these difficulties, and illustrated in Fig. 2, was built at the Newark Machine Shop, and was a great improvement over the former; but the designers had not fully appreciated the severity of the work that it must stand, and the frame being of wood only lasted about six months. About Sept. 1 a new motor car, of similar design but of much greater strength and power, was built by the Jeffrey Manufacturing Company, of Columbus. This motor car, weighing five tons, shown in Fig. 1, has been continuously hauling from the gathering partings in the mine to the head of the incline since it was installed. Its maximum load is thirty tons, encountering grades of four per cent. against the load, making the round trip in seven minutes, the distance being 2,400 feet.

A new trolley with four grooved wheels, so arranged as to run between the bars of channel iron which are placed about 8 or 10 inches apart was also designed. The current is taken from the trolley to the motor car by separate wires, which are perfectly insulated, and incased in a small cable. A still newer trolley line has been designed by the Jeffrey Manufacturing Company, consisting of two lines of gas pipe, one inch in diameter, encasing the copper wire. These are placed one above the other, about one foot apart, and the trolley is constructed with two grooved wheels so arranged as to run on top of the gas pipe. It is said to be much cheaper to construct, and at the same time forms a more perfect circuit than any line yet in use.

At the power house a 67 h. p. engine, running at 300 revolutions per minute, maintains a pressure of 250 volts. The motor uses 60 ampères while drawing the train, and 90 ampères while on the grade, being 16½ and 30 h. p. respectively.

The mining machine was built by the Jeffrey Manufacturing Company, and was delivered during the month of April. As the power plant had been completed and the conductors placed in the mine during the establishment of the haulage plant, no delay was occasioned in setting it at work upon its arrival. With the exception of changing one gear wheel to lower its speed, it has run continuously ever since. This is said, and it is believed truthfully, to have been the first economical electric mining machine installed in the United States. The writer witnessed the machine at work during the month of October.

The bearing in here is made in the fire clay which forms the coal floor of this region, and the average time consumed in making the cut was five and one-half minutes, the bar being three and one-fourth feet in length and the depth of under cut six feet. Owing to the lack of experience of one of the men in handling the cutting machines and the softness of the coal floor, nine minutes were consumed in resetting the machine between cuts, and at this rate the time necessary to make the under cut in a room twenty-seven feet in width would be two hours and eight minutes. The coal vein at this point is three feet seven inches in thickness, and it will be seen that a room will produce twenty-one and one-half tons of coal (run of mine). The time required in moving the cutting machine from one room to another was thirty minutes; this was about equally divided between the loading, moving and unloading preparatory to starting on the next room. From the above it will be seen that two men will make the under cut of four rooms in a day of ten hours, which will yield eighty-six tons of coal.

This can undoubtedly be increased as the men become more experienced in handling the machine. At the lower plant was maintained a pressure of 250 volts and the machine was consuming about 60 ampères, equalling 20 h. p.; the main conductor is of No. 4 wire. The inside conductors are No. 3 and No. 4 wire woven into a cable composed of four wires, the system being known as the double conductor circuit.

The second contract made in the State was entered into Dec. 17, 1888, between the Sprague Electric Railway and Motor Company, of New York, and Mr. William Job, for Ellsworth, Morris & Company. This contract provides for the erection of a 150 h. p. steam engine and two 75 h. p. dynamos, and the equipment of their Brush Fork mine, No. 2, in Hocking county, with one 15 h. p. motor car, six 15 h. p. motor mining machines, and three single horse-power motor drills, all by April 15, 1889. The first application of electricity was made on the motor car some time in June, and at this trial it was found able to draw but three loaded mine cars weighing two and one-half tons each up a 2 per cent. grade. It is said that to accomplish this required a quantity of electrical power equal to 15 mechanical horse power. This result was not as satisfactory as had been expected, as the common working load for a horse over this road in the past had been five loaded cars. During September, a second trial was made under the direction of another electrician who used a much larger conductor. This trial resulted in the same motor drawing ten loaded cars equalling 25 tons over the same road, using the same electrical power to perform the work. The marked improvement in this over the former trial demonstrated that, when properly applied, it would prove a success in economically handling the coal in the mines. Mr. Job was so favorably impressed with the experiment that shortly thereafter he began equipping their No. 3 mine, which is located on the opposite side of the ravine from the one just described, with a view of hauling coal from the extreme portions of the mine to the end of the present tail rope system. In equipping this mine No. 0 wire, which is about three-eighths of an inch in diameter, was used for the main conductor, to which the trolley line, composed of two No. 3 wires, is connected. The double-line system being the one in use here, the trolley is constructed to run on top of these conductors. It was near the close of the year before all was completed and working successfully. The motor car used in the first trials here pushes ten loaded mine cars, which weigh in the aggregate 25 tons, on an entry 1,600 feet in length, encountering grades against the load as great as 3 per cent. The time usually required in making the round trip is eight minutes. To accomplish this, a pressure of 230 volts was maintained at the power house, the motor using 60 ampères.

In the month of September Mr. Job placed in the mine an electrical mining machine, made in Columbus by the Jeffrey Manufacturing Company, which differs from the compressed air machines made by them in substituting the electric motor for the engines designed for the use of compressed air. Some difficulty was at first experienced in adjusting the brushes on the commutator from want of experience in handling this new power; this was soon overcome, however, and the machine has run continuously to the close of the year. To operate the machine a pressure of 230 volts was maintained at the power house, and a consumption of fifty ampères was required, equalling 15.4 mechanical horse power. The writer witnessed this machine at work on different occasions. The bearing-in being in the coal the average time in making a cut six feet under with a cutting bar three and one-fourth feet in length was 6 minutes and 50 seconds, the time consumed in running back 27 seconds, and run-back

and set 1 minute and 7 seconds, though one set was made in 53 seconds. The rooms are driven 26 feet in width, so that eight cuts and seven sets will finish a room, requiring 1 hour and 2¼ minutes to perform the work. To move this machine, which weighs about 2,400 pounds, from one room to another, requires 20 minutes, and at this rate, two men in this vein, which is seven feet in thickness, would under cut 177 tons of lump coal in nine hours. It will, however, be just to say that this exhibition was made by two experienced men, as was shown by their being able to make a run-back and set in the extraordinarily short time of 53 seconds.

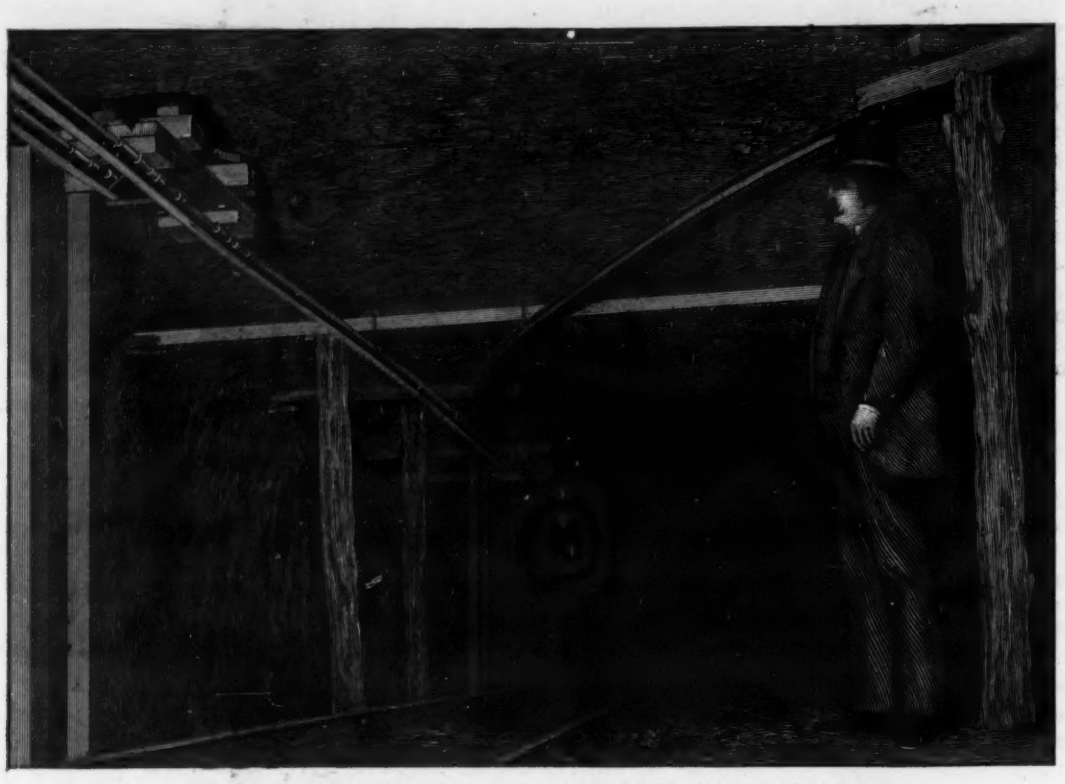


FIG. 3.—SCHLESINGER TROLLEY LINE AND SWITCH.

The third installation of electricity during the year was made at mine No. 19, owned by the Sunday Creek Coal Company, at Buckingham, in Perry County. The machinery was built and erected by Messrs. Schlesinger, Kimball & Co., of Columbus. The designs and application of this plant are the inventions of Mr. W. M. Schlesinger, a German engineer and inventor of what is known as the Schlesinger system of motors. The power plant consists of a 110 h. p. engine, which runs at a speed of 170 revolutions per minute, the electrical power derived from a 100 h. p. dynamo running at 500 revolutions per minute. This is conveyed through a drill hole in the floor of the power house to a point in the main entry near the bottom of the shaft, where it is connected with the trolley line, which consists of a line of 14-pound T-rail, running along the entry at such a height as to allow persons and mules to pass under it in safety. On this rail the trolley runs, which is so constructed that by means of a spring the wheels (four in number) clamp the head of the rail in such manner as to run on the web of the rail. The arrangement of overhead conductors is shown in Fig. 3. From the trolley to the motor car the current is carried by means of a series of wires, encased in a cover securely insulating it from danger of contact with those who operate the motor car, which is also the design of Mr. Schlesinger. It weighs 3½ tons, and is intended to exert 35 h. p. Fig. 4 gives a good general idea of its appearance. The line of entry over which it runs is 1,250 feet in length, drawing a train consisting of 18 to 23 cars, making an aggregate load of about 60 tons. These it gathers from a half-dozen partings in the mine. To run from one entry to another, Mr. Schlesinger has devised a very simple but ingenious switch in the conductor rail, which is readily moved and remains perfectly rigid in its place when thrown. At one of the gathering partings the motor starts its load against the grade of 4½ per cent., also on a curve having a radius of 12 feet. In performing this work a pressure of 430 volts is maintained at the power house.

The motor at its general work uses 50 ampères, which is equal to 29½ h. p. It has supplanted, in this mine, the place of 10 mules. To the operator this haulage plant glitters with practical features. For compactness, symmetry, and simplicity, the motor will commend itself to the public on sight, and time and experience will make it a formidable rival with any system in use in the State. Mr. Schlesinger has also designed a coal-cutting machine, though it is not as yet completed to form a feature in this article, beyond a brief description. It is composed of 11 drills, 2 inches in diameter, running horizontally, and so set that the perimeter of one cuts to the perimeter of the other. They are designed to make an under cut 3 feet in width and 4 to 6 feet in depth. Its weight, when complete, is 1,300 pounds, and it is said to resemble, in principle, a machine using compressed air that has given general satisfaction. When perfected, owing to its height and form, it will be especially adapted to working the thin seams of coal in the State.

Much has been written, and great alarm has been manifested as to the danger arising from coming in contact with the conductors, but the experience at the mines where electricity has been installed is that a 500-volt current is harmless to persons simply coming in contact with the conductors. The writer has repeatedly witnessed persons holding both wires of a double circuit for several minutes that were under a pressure of 250 volts.

With a view of determining the truth or fallacy of the claims made by electricians on the subject of increased adhesion by passage of the electric current into the rail, I have made calculations as to what a steam locomotive of equal weight would draw on the entries in the three mines of the State that are now hauling coal by electric motors. In doing this it is unfortunate that no reliable experiments are made public as having been made on mine cars to determine the resistance that has to be overcome due to axle bearings, grades and curves that are encountered in our mines of the State. We are also in the dark as to the coefficient of adhesion that would be applicable to the rails in the mines. Authorities differ widely on this question in railroad practice, they varying from $\frac{1}{10}$ to $\frac{1}{4}$.

In consideration of the fact that all the tracks in the mines herein considered have been drained and are as dry as the atmosphere of the mine will permit and the additional fact that sand is liberally applied at all times and the low speed attained by the train, the writer determined to use the coefficient of adhesion 1-3 or .33 equal to 667 pounds per ton of the weight on the drivers. The dust which arises in a mine when it is composed of finely pulverized coal, instead of acting as an element to increase adhesion will, on the contrary, become a lubricant.

At mine No. 19, owned by the Sunday Creek Coal Company, at Buckingham, in Perry County, the Schlesinger motor and system there at work present this proposition: What will a locomotive weighing four tons draw on a 4½ per cent. grade around a curve of 11 feet radius (the grade on such course beginning with a 4½ per cent. and ending with a grade of one per cent.) at a speed of four miles an hour, the length of the motor car being 9 feet; length of mine car, 8 feet; weight of mine car when loaded, 5,000 pounds? Here a new element, that of gauge and curve, enters the computation.

Before entering into this computation it will be observed that this is the only mine in the State where the current is returned through the rails; consequently, the only opportunity that is presented under the writer's observation of drawing a comparison between the two systems with a view of determining the foundation for the claim of increased adhesion produced by passing the electrical current through the driving wheels into the rails, the train resistance remaining the same, six pounds.

The formula $\frac{\sqrt{w^2}}{171}$ equals 16 divided by 171, equals:

	Lbs.
Resistance due to speed	.093
Resistance due to grade $\frac{2,000 \times 4.5}{100}$	90.
Total train resistance per ton of train due to grade, speed and train resistance of that portion of the grade on which the track is straight	96.093
On the curve the train resistance remains constant at	6.
The resistance due to speed remains the same	.09
The grade (receded from 4.5 per cent. to 1 per cent., average grade 2.75x.3815)	55.3
Curve resistance (.125 for each foot in width of gauge equals 3x.375x528 D. C.)	198.
Train resistance due to each ton on the curve ... Degree of curve, 528. Length of curve, 17 feet.	259.39

It will be seen that two cars are on the curve, and five tons on the curve will have a resistance of five multiplied by 259.39, or 1,296.9. One ton of the locomotive has an adhesion of 2,000 pounds, multiplied by .33 equals 667 pounds. Then will 1296.95 pounds, the resistance offered by five tons on the curve, divided by 667 pounds, the adhesion of each ton of the locomotive, give 1.94 tons of the power of the locomotive that is required to draw that portio of the train that is on the curve. The locomotive weighs four tons; we then have four tons, less 1.94 tons, which equals 2.06 tons remaining to draw that portion of the train remaining on the grade.

2.06x2,000×.33 equals 1,359.6 pounds, the adhesive weight of the locomotive remaining to overcome the train on the grade.

Total resistance per ton on grade equals 96.093 pounds.

The unexpended power of the locomotive is 1,359.6 pounds, which divided by 96.093 pounds, the resistance due to each ton upon the grade will equal 14.05 tons. The total load that a locomotive weighing four tons can draw on this grade and around the curve will be 14.1 tons plus 5 tons, equals 19.1 tons, less the weight of the locomotive, which is four tons, equals 15.1 tons, the load drawn by an ordinary steam locomotive.

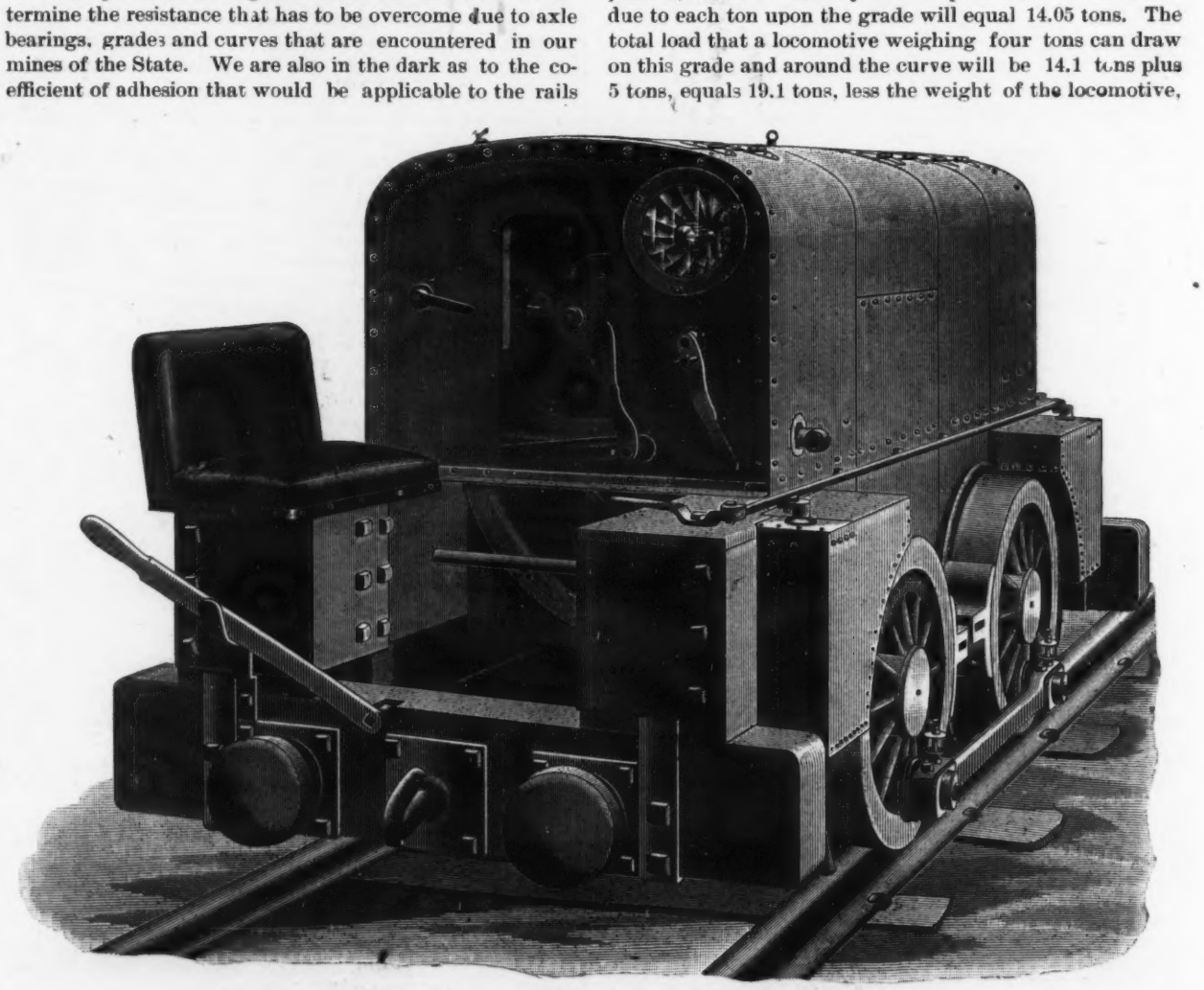


FIG. 4.—REAR VIEW OF THE SCHLESINGER MINING MOTOR.

The weight drawn by the electric locomotive over the same road is 22.5 tons, which shows an increase in efficiency of 7.4 tons; this equals a gain of 49.1 per cent. in favor of the motor car.

The data for these calculations were gathered by the best means at hand, as no scientific tests have been made, until experiments have been made to accurately determine the exact coefficient of train resistance, also the resistance due to the irregularly-laid curves in the mines, the adhesion on mine rails, and to what extent coal dust enters into its reduction, also to determine the accurate rate at which the train enters the curve and the speed at which it leaves it.

Proceedings of the Twelfth Meeting of the National Telephone Exchange Association.

FIRST SESSION.

The Association was called to order at 11:30 A. M., the president, William D. Sargent, of Brooklyn, N. Y., in the chair, and C. H. Barney, of New York, secretary.

The PRESIDENT: Gentlemen, the first business is the calling of the roll. Gentlemen will please answer their names as they are called by the secretary. I might say, before the roll call, that Mr. Jackson requested me to announce that he had expected that the Mayor of the city would be here to welcome us; but he tells me that the Mayor has been called away on some important business, and will not be able to be present. But I presume that the hospitalities of the city have been extended to us anyhow, and we will have to get along without the actual welcome.

The SECRETARY: If the members of the Association, besides answering to the names of the companies which they represent, will kindly fill out a card which Mr. Morgan will distribute, and send them up to the secretary's desk, we will be able to get a complete list. (The secretary called the roll.)

The SECRETARY: Mr. President, the calling of the roll shows that there are represented 26 active members, three associate members and six honorary members.

The PRESIDENT: The next business, I believe, is applications of new members. Are there any applications?

The SECRETARY: I have received no new applications.

The PRESIDENT: Then the next business before the meeting will be the reading of the secretary's report.

The secretary read his report as follows:

SECRETARY'S REPORT.

NEW YORK CITY, Sept. 2, 1890.

To the National Telephone Exchange Association:

GENTLEMEN: I have the honor respectfully to submit my report of this Association for the year ending Aug. 31, 1890.

At the beginning of the Association year the roll contained the names of 34 active, 6 associate and 27 honorary members. The changes during the year have been as follows:

At the Minneapolis meeting the resignation of the Sunset Telephone-Telegraph Company, of San Francisco, as an active member, and of Clark B. Hotchkiss as an associate member were both accepted, and the Callender Insulating and Waterproofing Company was dropped from the roll of honorary members, it having gone out of business. At the same meeting the Cumberland Telephone and Telegraph Company was re-elected to active membership, and Messrs. Felton and Gilleaume, of Cologne, Germany, were elected as associate members. Mr. A. G. Day, an honorary member, has died during the year. These changes leave us with a membership at the close of the Association year as follows: Active, 34; associate, 6; honorary, 25.

There is now in my hands, to be presented to the Association, the resignation of the City and Suburban Telegraph Company, of Cincinnati, as an active member, and of J. A. Roebling's Sons Company, of New York City, as an associate member.

The office of the secretary has remained at 510 West Twenty-third street, New York City, during the entire year. The usual number of inquiries for information have been received and replied to, and the *News Letter* has been regularly issued, semi-monthly, until Jan. 1, 1890, and monthly since that date. The treasurer's report will show that the income of the Association has, during the past year, considerably exceeded its expenses, by reason of a reduction in the latter. There is now in the treasury a balance of $320.99, as against $66 41 at the beginning of the year. All accounts due the Association have been collected, and all debts of the Association have been paid to the end of the fiscal year. The income of the year was derived as follows:

From annual dues	$1,950.00
From initiation fees	10.00
From sales of extra copies of proceedings	49.15
Total	$2,009.15

The expenses have been distributed as follows:

For salary of secretary	$1,000.00
For printing proceedings, Minneapolis meeting	245.25
For other printing, *News Letter*, circulars and blanks	129.40
For office expenses, stationery, postage, telegrams, express and newspaper clippings	98.06
For stenographer at Minneapolis meeting	136.50
For other expenses at Minneapolis meeting	145.36
Total	$1,754.57

Respectfully submitted, C. H. BARNEY, secretary.

On motion, duly seconded, the report was accepted and placed on file.

The SECRETARY: Mr. President, as has been stated in my report, there are the resignations of the City and Suburban Telegraph and Telephone Company, of Cincinnati, as an active member, and of J. A. Roebling's Sons Company, of New York, as an associate member. Both these resignations were received at about the beginning of this association year, or within 15 minutes after the Minneapolis meeting. There having been no meeting since of the Association, or of the Executive Committee, they could not be acted upon until the meeting of the Executive Committee last evening.

On motion of Mr. GIFFORD, duly seconded, the resignations were accepted.

The SECRETARY: I have also received the resignation of Mr. George M. Stone as a member of the Advisory Committee of this Association.

On motion of Mr. ULINE, duly seconded, the resignation was accepted.

The PRESIDENT: The next business in order will be the reading of the treasurer's report.

The TREASURER: I have a report here of the details of the Association's business, and about the vouchers, which has been examined and approved by the Executive Committee. The balance brought forward from last year was $66.41; cash on hand, $320.99. This is an improvement of about 500 per cent. over the report made a year ago. Shall I read the report in detail?

A MEMBER: I move that the reading of the report be dispensed with, and that it be accepted and placed on file.

The motion was seconded and carried.

The PRESIDENT: The next business, I believe, is the reading of the minutes of the meeting of the Executive Committee.

The secretary then read the minutes.

On motion of E. J. Hall, Jr., duly seconded, the same were accepted and adopted.

Mr. GIFFORD: Perhaps some of the members do not understand the hours of meeting which the report of the Executive Committee has mentioned, and I would suggest that the chair repeat them.

The PRESIDENT: From 11 o'clock to 1 o'clock and from 3 o'clock to 5 o'clock to-day, and to-morrow from 10 o'clock until 12:30. If there is to be any extension of the time a motion to that effect can be made at the session to-morrow morning.

Mr. GIFFORD: I believe it would be correct to state that the committee thought that all the business could be transacted in these two days, and if it was necessary to extend the time longer we could arrange to do so on Thursday morning.

Mr. JACKSON: I would announce, Mr. President, that there will be a carriage drive tendered to the members of the Association and those attending this convention at two o'clock to-morrow, weather permitting. We will drive around the city and to Island Park, with a lunch to be served at the Casino. This invitation is general to both gentlemen and ladies accompanying them, and to all others who are here at the convention. There will be no printed invitations for this drive; for the other entertainments there will be printed invitations issued, and therefore I beg to announce that all are invited, and we hope all will come. Ample preparations have been made for all who wish to participate. (Applause.)

The PRESIDENT: I may say that the committee had notice of this invitation and that the hours were arranged to make it possible for members to accept the hospitality of the Detroit company.

The TREASURER: I suppose that that spontaneous outburst of applause was equivalent both to accepting the invitation and to thanking the donors for it. If it is not, I would move that the invitation so gracefully tendered us by Mr. Jackson be received with thanks. (Applause.)

The motion was seconded and carried.

The PRESIDENT: The next business is the nomination and election of officers, and before nominations are made I will ask the indulgence of the Association to listen to a few remarks that appear to be pertinent to the occasion of the tenth anniversary of the Association. On Sept. 7 just ten years ago the first convention of telephone men assembled at Niagara Falls. The meeting was the result of a circular sent out some time beforehand, signed by representatives of the leading telephone companies in the United States. The object of the convention, as stated in the circular, was the "formation of a general telephone association to consider the various questions affecting the telephone business and its development." This meeting was organized by the election of George F. Durant as chairman and E. J. Hall, Jr., as secretary. The roll of representatives showed 86 individuals representing various companies, six representatives of the American Bell Telephone Company, and 21 representatives of manufacturing interests, making a total of 113 individuals. A constitution and by-laws were offered, and various reports and papers were listened to and discussed, after which the convention, on the morning of Sept. 9, adjourned sine die. Immediately following this adjournment, and on the same day of which this is the anniversary, the first meeting of the National Telephone Exchange Association of the United States assembled. The present constitution and by-laws were adopted, and the following officers elected: President, Geo. L. Phillips; vice-president, H. H. Eldred; secretary, M. F. Tyler; treasurer, D. I. Carson. The Association then adjourned to meet in Chicago on the first Tuesday in April. The subsequent meetings in Saratoga, Boston, Cincinnati, Philadelphi , and so forth, are a part of the history of our business. Of the original members many have left the business, and a few—but all too many—have been taken away by death, notably our universally esteemed first president, George L. Phillips, and others no less dear, and of whom the Association has expressed its appreciation in just and loving tributes to their merits.

Ten years ago how rude the business was. The multiple switchboard was a mere idea. Cables were only hinted at. The use of iron or steel wires was almost universal. Insulation was considered of little account by many, and some declared insulators superfluous (laughter). The value of the service was underrated by the public, and our own standards were far below those of to-day. The highest efficiency and reliability is what the public demand of us, and business and prosperity will follow us just as fast as we are able to meet that demand. The standard of to-day requires the use of copper for conductors, overhead as well as underground, and the substitution of metallic circuits for single grounded wires. The underground wires and cables of five years ago do not answer the requirements of to-day, and the same may be said of central office and subscribers' equipments. With improved service comes increased use by the public, and the ability and energies of the best minds in the business may well be taxed to the utmost to keep up with the demand.

This Association has in the past been active in the development and extension of new ideas and improved methods, and it is therefore with regret that I call your attention to the lack of interest and the falling off in membership during the past three or four years. The City and Suburban Telephone and Telegraph Company of Cincinnati has resigned, and the active membership is now only 33. The secretary's request for papers to be read at this meeting met with no response. The papers which we have were procured by personal solicitation on the part of the officers. It may be said, indeed, that outside of the secretary's statistical report the furnishing of papers to serve as topics for discussion during the last few years has been done by a very few individuals. If the Association is to be of service in the future its members generally must take a more active part in the preparation of the papers and reports which form the basis for our discussions.

In conclusion, I desire to thank the members of the Association for the kindly manner in which they have treated an inexperienced presiding officer. (Applause).

Mr. CRANDALL: Did I understand the chair to announce that the next order of business was the nomination of officers?

The PRESIDENT: Yes, sir; nominations are now in order.

Mr. CRANDALL: Then I desire to place in nomination a gentleman who a few years ago composed one of the vanguard that was leading the way teaching many of the members of this association what telephoning would be; I desire to place in nomination a gentleman who has filled many important positions in telephone service, and has never been found wanting in any; I desire to place in nomination a gentleman who is now filling a position in the telephone service, and who has filled it, I believe, to the satisfaction of every member of this Association—I have the honor to nominate for president of this Association for another year our worthy president, Mr. Sargent, of New York. (Applause.)

The motion was duly seconded, the question put by Mr. Crandall, and unanimously carried.

The PRESIDENT: Gentlemen, this disagreeable shock to my modesty having been accomplished, I can only return my sincere thanks for the continued honor bestowed upon me, and I trust that our relations in the future will be quite as pleasant as they have been in the past. We will proceed to the next business, which is the nomination of a vice-president.

Mr. WILSON: I desire to nominate for vice-president Mr. F. G. Beach. (Applause.)

The motion was duly seconded.

Mr. TYLER: As our election ought strictly to be by ballot, I move that in the absence of other nominations the secretary be directed to cast one ballot for Mr. Beach.

Motion was seconded and carried unanimously and Mr. Beach declared elected vice-president.

Mr. BEACH: This is a matter of great surprise to me and I can simply say that I thank you all heartily. (Applause.)

The PRESIDENT: The next business in order will be the nomination of treasurer.

A VOICE: You have got to do it yourself, Storke. (Laughter and applause.)

Mr. HIBBARD: In the absence of other nominations I rise to move the nomination of—(great laughter). Well, you all know whom I mean. Will anybody second the nomination? (Renewed laughter.)

The PRESIDENT: It is moved and seconded, I suppose, that the secretary be directed to cast the ballot of the Association for our modest treasurer, H. L. Storke, to fill the office for the ensuing year. All in favor of that will say aye.

Carried unanimously.

The TREASURER: I rise to return my sincere thanks for the cordial and unanimous manner in which I was nominated. The convention appears to be of one mind, and if silence gives consent, I am still your treasurer. (Great laughter and applause.)

The PRESIDENT: On account of the resignation of George M. Stone, of the Advisory Committee, there are two vacancies. The third member is Mr. M. F. Tyler, who holds over for another year. Nominations are in order for one member of the Advisory Committee for a term of three years, to fill the unexpired term of Capt. Stone.

Mr. E. J. HALL, Jr.: I desire to nominate for the three-year term Mr. W. A. Jackson—I had intended to say of Detroit, but that sounds so much like introducing a man who does not need any introduction, that I will omit it.

The motion was seconded, and the secretary was directed to cast the ballot of the Association for Mr. Jackson, which was done, and he was declared elected.

Mr. IVERS: I now move that Mr. E. B. Crandall be elected to take the place of Capt. Stone.

The motion was seconded, and the secretary was directed to cast the ballot of the Association for Mr. Crandall, and he was declared duly elected.

The PRESIDENT: There are now four members of the Executive Committee to be elected. The present members are Charles F. Cutler, Charles H. Wilson, H. N. Gifford and the president.

Mr. EASTERBROOK: I would ask the secretary if it is usual to elect these members of the Executive Committee in a body, or one by one?

The PRESIDENT: The chair would state that the Association may act at its pleasure about that. They may all be nominated and elected at one time, or separately.

Mr. EASTERBROOK: I should like to place in nomination E. J. Hall, Sr., of Buffalo; Charles F. Cutler, of New York; Charles H. Wilson, of Chicago, and H. N. Gifford, of Louisville—three members of the present committee with the addition of Mr. Hall, of Buffalo.

Mr. CRANDALL: I second that nomination, and move that if there is any reason why we should not elect them at once that the secretary be requested to cast one ballot of this Association for them.

Mr. EASTERBROOK: I will ask unanimous consent for that to be done.

The PRESIDENT: There is nothing in the constitution or by-laws which prevents balloting for these members at one time.

By direction of the Association the secretary cast one ballot and the gentlemen nominated were duly elected members of the Executive Committee for the ensuing year.

The PRESIDENT: What is the further pleasure of the Association? I may say that the Executive Committee have had two or three papers which have been offered to the Association, and if there is no other business we will proceed to the reading of these papers. It was expected that the speech by the Mayor of this city and the little speech that the president had to say in response thereto would take up all the time of the morning session. The first paper is one prepared by Mr. Davidson, of Brooklyn and I would ask Mr. Carty to read that paper as Mr. Davidson is not present.

Mr. Carty then read the paper, which is as follows:

THE OPERATION OF THE DOUBLE CORD KEY-BOARD AT BROOKLYN, N. Y.

A year ago, I addressed a somewhat extended report regarding the workings of the new multiple switch at Brooklyn,* as then operated with the single cord key-board. On account of the troubles therein shown, and because it was essential that we should be able to operate mixed circuits in the multiple board, it was decided to change the key-board from the single cord grounded system to the double cord metallic. This change was completed early in March, 1890, and the new key-board has, therefore, now been in use for about six months.

The equipment is full metallic, with tubular clearing out drops, retardation coils, condensers, split telephones, etc., etc. The change required the connection of answering spring jacks which were placed horizontally in the lower part of the switch, necessitating the moving upward of all the spring jacks originally connected. This movement disarranged the switch cable wiring to some extent, and increased the liability to troubles in that particular, but very little has developed. The wiring of the line drops had to be entirely renewed, these having been wired originally for grounded circuits only.

The number of troubles, as shown by the table herewith, is very low, and those occurring were almost entirely of a trivial nature, readily located and easily removed. In the parts of the apparatus not referred to in the tabulated form, there has been scarcely any trouble. After the change of key-boards had been completed, new transmitter cords were put in, none of which have failed; triple receiver cords were necessarily substituted for the double cords, and only one of these has failed. One of the condensers became short circuited, the result of which was to cause all grounded circuit lines to test "busy" whether in use or not. The split telephones have been very satisfactory, no trouble whatever having been experienced in their use.

Spring jacks.—We have added 1,720 spring jacks to the 15,660 in use last year, making 17,380 now in use. For the first 13 months' use there were 10 cases of dirty contact; for the past six months, there have been 22 cases of this

* See THE ELECTRICAL WORLD, Sept. 21, 1889.

trouble. I think this increased percentage of trouble is due to a considerable extent to the disturbance of the switch cables at the time of changing the system, which set free whatever slight accumulation of dust there was in the cables, no small portion of which found lodgment in and about the spring jacks. None of the spring jacks have platinum contacts, the use of which would, I think, lessen this difficulty.

Drops.—There are 1,770 of these in use, an increase of 110 over last year's report. The troubles with these have been much fewer than was previously shown, comparing as follows:

	Thirteen months. 1889.	Six months. 1890.
Catch	26	3
Shutter	36	8
Armature trunnion	203	None.
Crossed with core	6	1
Open in coil	2	1
Burned out	1	5
Broken wires	20	8
Total	294	26

None of these troubles require any special comment, the cause and remedy of each being apparent.

Ringing keys.—The ringing keys are of the pattern known as long-distance metallic, and there are 273 pairs, or 546 individual keys in use. Only five cases of trouble have developed, four of these being a failure to ring, caused by the generator springs not being properly adjusted, being so far away that the depression of the button did not close the contact between the line and generator springs. The remedy was easy and is obvious. The other case of trouble was where the button, being depressed, would not return to its normal position. This was due to a slight roughening of the sides of the wedge-shaped rubber plunger where the springs rest against it. A little oil applied at the point of trouble was all that was necessary.

Listening keys.—There are 273 listening keys in use with which there have been 41 cases of trouble, no one of which, however, was in the main line circuit, or interfered with the subscribers after a correction had been made. These 41 troubles may be divided into four classes as follows: Failing to cut in operator, 9; failing to cut out operator, 1; rubber plunger sticking, 27; rubber pin broken, 4; total, 41.

Failing to cut in operator.—The nine cases of this trouble occurred in the first two months, and on account of the springs not having been properly adjusted when they were connected. The springs rested against the rubber plunger and did not close the contacts on the operator's circuit. There was no recurrence of the trouble after properly adjusting the springs by bending them.

Failing to cut out operator.—There was only one case of this trouble caused by the rubber pin of the plunger being so short that the "throw" was not great enough to break the contacts.

Rubber plunger sticking.—This trouble occurred 27 times, and, as in the case of the ringing key, was where the plunger remained down when the cam was thrown forward. It was due to some extent to a lack of proper smoothness of finish on the wedge-shaped sides. The plunger is pressed upon by two springs on one side and one on the other, the unequal strain having a slight tendency to make it bind. The difficulty was readily overcome by rubbing a little oil on the sides of the "wedge."

Broken rubber pin.—Four of the little rubber pins which are acted upon directly by the cam became broken from some unknown cause. The cams of the listening key make considerable noise when they are thrown forward, but I do not know how this can be avoided.

Tubular clearing-out drops.—There are 273 in use, which have required attention 23 times. All of these troubles, except two, were with the catch. The drops are located directly in the rear of and on a level with the cords, the plugs of which in being returned to their normal position occasionally strike against and bend to some extent the rather slender catch of the drops, which in consequence fails to release the shutter. The remedy for these troubles, after their occurrence, is obvious. To guard against them, the drops should be located elsewhere, which, however, is not practicable in this switch. The "adjustments referred to were where the armatures were too loose, requiring the changing of the position of the trunnion binding screws.

Cords.—It appears from the record that only about 35 per cent. of the cords in use had failed during the six months. As a matter of fact, the percentage of failures of the cords *actually used* is much greater. Each of the subscriber operators has 18 pairs of cords available, but habitually used a much smaller number, a half dozen or so pairs of cords being used for the greater portion of the connections, the other pairs in a lesser and lesser degree, according to the volume of business. There were a few failures of the cords at the point of soldering into the shoe, inside of the plug, but the percentage of troubles from this cause is very low. Almost all of the failures are just at the base of the plug, due to the strain upon the cord in withdrawing the plugs from the spring jacks. The breaking of the tinsels is increased considerably by the perspiration from the operator's hands penetrating the covering of the cords. It is the rule that operators shall withdraw the plugs by taking hold of the same, and not by the cord, but it is almost impossible to enforce the rule on long reaches.

The percentage of cord troubles in the double metallic is very much greater than in the single cord grounded system. In the 13 months' use of 1,200 single cords there were only eight failures, as against 209 failures in six months out of 576 in use in the double metallic. There are two prominent reasons for this increased percentage: first, because as there are two conductors in the metallic circuit cords the liability to trouble is doubled in the same number of cords, and second, because in the double cord system the use of the cords is so much greater. In the single cord system a cord is not used except to complete the connections for which the subscriber, of whose line it forms a part, may call, while in the double cord system a pair of cords may be used any number of times, in fact, may be used almost continually. The one case of trouble, "conductors crossed in cord," was caused by abrasion of the insulating material. The effect of such a crossing of the line or test is that any grounded circuit subscriber's line tested with that pair of plugs would show "busy" whether in use or not.

Plugs.—The troubles with the plugs have not been many, amounting to 13 in all out of 576 in use. Four tips of plugs were broken off in the spring jacks, due, however, more to accident and a lack of care than to faulty construction of the plugs. The removal of one of these tips from a spring jack is a somewhat difficult matter when it happens to be broken off when the plug is wholly within the jack and the tip held fast by the line spring. It is then necessary to relieve the tension of the spring by partially or wholly withdrawing the screw holding it in place, and pushing the tip forward until it is within the sleeve of the "test." From this point, I find the most convenient plan of removal to be the use of a short piece of flexible rubber tubing; placing one end of the tubing firmly over the opening of the spring a quick inhalation of breath rarely fails to bring it out.

Tips unscrewed—The little rivet used to prevent such troubles has come out of nine plug tips, rendering it unsafe to use the plug until repaired.

Referring to last year's report, it will be seen that in the 13 months' record there were 459 cases of trouble with the combination key and 76 with the grounding jacks, a total of 535 in the single cord key-board, or an average of a little over 41 per month. The report herewith for six months shows troubles in the double cord key-board as follows: Ringing buttons, 5; listening keys, 41; clearing-out drops, 23; a total of 69 or an average of 11½ per month. When it is further considered that about 40 per cent. of the troubles in the single cord key-board interfered with the subscriber's conversation after the connection had been made, and that not one of the double cord troubles interfered in this way at all, the contrast is very great. Add to this, too, the great difference in the ease with which repairs may be made to the double cord system and that the making of such repairs need not interfere with the operator's efficiency nor with any subscriber's line, it seems to me that there can be but one conclusion arrived at.

On motion, the thanks of the Association were tendered to Mr. Davidson for his interesting paper.

The PRESIDENT: Are there any remarks on this paper?

Mr. LOCKWOOD: I wish to express my belief that the conjunction with which we were favored at the end of that paper may possibly have referred to a "to be continued in our next." Now, if I may be permitted to express the opinion upon the record which you gave utterance to in your preliminary remarks, it is this: that one of the reasons, or so it seems to me, for the scarcity of papers in our later meetings is the dearth of discussion which has taken place upon any papers which have been heretofore read. My experience in associations and various organizations is that the bulk of advantage which is gained is derived from full and free discussion. A paper of itself, no matter how praiseworthy or how replete with information it may be, is still necessarily incomplete unless it elicits the views of hearers who are well adapted to speak upon such subjects. I cannot refrain from expressing my own views in regard to this paper, that it is one of the most practical that has ever been presented before this Association. It is brief, pointed and full of information from beginning to end, and just such information as is valuable in our central office work. Some two years ago I visited Brooklyn, shortly after the single cord switchboards were set up there, and I had the pleasure of meeting the author of this paper, and was much impressed with his ability and intelligence, and especially with regard to the attention which it was evident to me he bestowed upon detail. With the permission of his superior officers, I obtained a copy of a report which he made after a certain number of months' operation of this switchboard, which went through just such features and with just as much detail as the paper to-day has done. It brought out in a clearer and more conspicuous way than I ever saw before the immense variety of faults and evils which a central office switchboard is capable of developing. These are of course largely due to the complexity of the operations to be performed. When we consider the calls to be received from the subscribers, and consider also that the operator must ascertain whether the line desired is already in use, and when we consider that the second subscriber must be called, and that the two lines are then to be united for conversation, and that the conversation must be largely guided and supervised, and that finally the disconnecting appliances are to be supplied, it is not surprising, I say, that this organism frequently gets out of order. It requires the most constant supervision of any electrical instrument that I know of, for many reasons. Each line has to pass through a great number of contacts, and necessarily so. The instruments for receiving calls have to deal with currents which are not strong, and sometimes which have to pass over unavoidably leaky lines which cannot at all times be kept in the highest order of repair. The instruments through which the talking is performed, namely, the transmitting and receiving telephones, do not generate a strong current at the very best, and frequently it is a very weak one—the weakest, as we are in the habit of hearing, known which is capable of accomplishing any useful result—and therefore I say that the troubles which appear are not altogether, either in number or in variety, greater than might have been expected if we stopped to consider what the current was with which we were dealing and of the very uncertain nature of all machinery, especially when it is worked to such a large extent as is a central office switchboard.

There was one other thing which also impressed me, and that was the very great improvement which took place this year in comparison with the year 1889. This, I think, shows constant supervision, and the paper corroborates my view that there must have been constant supervision in the number of faults and the number of ways in which faults have been detected, and a very large number of points especially connected with lines of flexible cords. And so, Mr. President, it seems to me that the author of this paper deserves not only a vote of thanks, but our heartfelt appreciation as well. (Applause.)

At this point the vice-president was called to the chair, and President Sargent addressed the Association as follows:

"I would like to say in regard to that paper, that while it may seem to members that it ended a little abruptly, the facts presented are so obvious to the writer that in making that concluding remark he supposed that everybody would see that the double cord switchboard, which he had just described, was so far superior to the single cord switchboard that he did not need to put that into words. There is far less trouble with the use of the double cord than with the single cord board. The trouble with the single cord switchboards is in their removal; they usually bring in other trouble and prevent the operator from doing the work properly, and altogether create a great deal of trouble, whereas, with the double cord board, all these troubles may be gotten at and removed without interfering in the slightest degree with the efficiency of the operator. And I think the record shows conclusively that the use of the double cord—indeed, the use of a key board that is entirely separate from the wires—is the best."

Mr. CARTY: I may say a good deal about the merits of the double and the single cord switchboards, but as far as the work is concerned there are no single cord switchboards which are adapted for mixed circuits, and until we have one that is, I think it places it far beyond the range of discussion—that any discussion of the relative merits of the two boards, until we get an extra circuit single cord board, would not be very profitable. When an exchange comes to consider the question of a new office, whether a board is adapted to a metallic circuit is the first question, and if it is not so adapted it is usually thrown out.

Mr. KELLOGG: I would like to ask if there is a single cord switchboard in use in the United States to-day?

Mr. LOCKWOOD: Yes, there is one at Columbus.

Mr. WILSON: In answer to the gentleman's question, I will say that we have a single cord board in operation in Chicago in the main office, arranged for single wires and grounded circuits. We also have a single cord metallic circuit switchboard in operation in the stock yards office in Chicago. It fills all the requirements for metallic circuits, but, as compared with the double cord metallic circuit switchboard, it has not been considered so good on account of mechanical details. I would say also for the information of the gentlemen present that we in Chicago had the metallic circuit problem to contend with, and we were not anxious to introduce any more experimental apparatus in our general system than we could help. So we took one of our branch offices to experiment with, and we have in operation in that office now five different metallic circuit key board systems. The spring jack part of the switchboard is the same in all of them, and, as the different systems dove-tail together, we are able to operate the five different schemes in the same office. We have been doing that for six months or more, and from those five different schemes we have adopted one for use in our main office, and the apparatus is now being constructed for that. But the single board scheme has had to give way for one of the double board schemes, on account of the advantages of the latter over the former.

Now, I want to say that the part of the paper which has been read which interested me the most is the reference to troubles in the spring jack. We found in Chicago, where we have long underground circuits, that the introduction of a small amount of resistance in the circuit makes a very great difference in the talk, and it is particularly apparent from our office why the incoming trunk line business from the branch offices don't pass through the spring jack—through the springboard. The trunk lines end in cords and plugs. The outcoming trunk lines necessarily dupiicate through the switchboards, passing through 19 sections of the switchboard and 20 spring-jack contacts. If the contacts in the switchboard become dirty—not necessarily open to interrupt the circuit entirely—we notice a difference between the incoming and the outcoming talk, and we have found that a resistance of 200 or 300 ohms in a contact makes a very appreciable difference in the conversation. Some six months ago we organized a labor force to work every night on our switchboard, and the series of contacts through the switchboard have been measured with a galvanometer, and if a resistance exceeds 150 ohms—that includes the drop, which is 100 to 130 ohms—the spring jacks are all cleaned. In that way we keep our service reasonably uniform. Our experience is that after six months' hard work in cleaning up the contacts we still have on an average from five to ten cases of trouble a day. That does not mean open contact. And I would like to ask if the statistics given in the report refer to open contacts only, or to dirty contacts. If it is only open contacts it might be consistent with our experience. If it is dirty contacts, where resistance of 200 or 300 ohms would be called a cause of trouble why then I cannot understand the difference between our experience and the experience East. In order to ascertain what the experience of other companies was I arranged to get some reports from New York at one time and Boston, through the Western Electric Company by the kindness of Mr. Bartlett. I was very much relieved to find that our troubles were less than theirs, which I attributed to the pains we took every night to clean the contacts. But the report that we have before us now is so much superior to anything that I have heard that I would like to have it explained if there is any person here who understands exactly what the report means. I think that dirty contacts in the spring jack in every large office is a very important and serious trouble. We have now 65,000 spring jacks in our main office switchboard and we are about to increase it to three times that number, and unless we can eliminate the cause of the trouble we shall naturally expect just about three times as much trouble of that kind, and, as the number of spring jacks increase on their line, the percentage of trouble to the stockholders must necessarily be increased.

Mr. GIFFORD: I want to compliment the author of this paper as well as the reader of it, and I want to express my pleasure for the information which President Sargent gave us as to why it stopped so suddenly. You remember that about a year ago in the middle of an eloquent address that I was making, I stopped very suddenly (laughter), and it helped me out of a point that I wasn't able to explain. I was speaking of electric light and electric railway experiences and suddenly discovered that I was trenching upon something I had better not discuss, and I thought that some time if I had the opportunity I would apologize, and if, as Mr. Carty has spoken, that was the cream of the whole thing, why I think it is esteemed that I was fraught with wisdom. He said it was unnecessary to say that, because of the wonderful wisdom of this Association. (Laughter.)

Now, in regard to this report of trouble, I think that the Brooklyn people ought to be congratulated on the small amount of trouble they have. Our trouble in Louisville is, that we have a considerable number of dirty spring jacks. We have a detached building that we occupy in the middle of a square. My wire room and shop is underneath, but I have a floor very heavy, four or five inches thick, and very little dust can get through; and when the janitor sweeps our room he sprinkles sawdust so as to avoid raising the dust; but in spite of all our precautions we do have very dirty spring jacks, and it has been the cause of a great deal of trouble. A subscriber will say that he cannot hear anything, and we first examine the battery. If we don't find anything wrong there, then there is a suspicion of a loose joint, or an old iron wire, and we go over those things carefully and if we find any trouble it is removed. But then, after that is done, sometimes the thing won't work, and then we look at the spring jacks; we find that a large percentage of our trouble with inside service arises from those dirty spring jacks. We had to go to work and clean out those little springs. A short time ago I detailed three or four em-

ployés to go through nights and clean out the whole switchboard. I tell you you have got to go through and clean out your whole switchboard every month.

Then, too, we have had a great deal of trouble with broken cords. We have an exchange of not quite 2,400 subscribers. I find that we have from 25 to 40 broken cords every day, and, of course, they are a serious cause of difficulty. A man calls up a connection, the operator connects him and then he cannot hear anything. That is a very serious trouble. We have tried the ordinary tinsel furnished by the Western Electric Company, and then we tried a combination of tinsel and spiral wire. At last we concluded to have a cord made to suit ourselves, composed of about three times as much tinsel as is ordinarily put in, and that cord gives us a great deal of satisfaction. I have told my electrician to be just as extravagant as he likes in the use of the cords, and to put in new cords of this kind whenever any cord is out of order. In regard to the listening tube, we have a great deal of trouble with these little hard rubber plungers. They get worn, they get dirty, and they are very hard to get at, and we have a great deal of trouble. They are causing so much, in fact, that I was about deciding that I should have to go home by way of Chicago and see if they could not devise some remedy for it. The Warner lever there gives great satisfaction. I think we should call the attention of the manufacturers to these difficulties, and see if they cannot do something to remedy them.

Mr. HIBBARD: I wish to mention it as a matter of observation in exchanges pretty much all over the country that the dirty jack trouble is more noticed in places West where they do not burn hard coal and where the whole atmosphere is permeated with dirt and dust; also, in places where an exchange is located near a railroad yard, where smoke and soot from the engines float in through the windows. I think it may be possible that that is a reason why we do not have so much trouble with dirty jacks in Brooklyn as they have out in Chicago and Louisville. The Brooklyn office is a neat, clean office—as clean as a parlor. It is a great deal cleaner than this room is. I don't think they even have to throw wet sawdust on the floor and tackle it with brooms afterwards, either. (Laughter.) The Buffalo exchange has linoleum on the floor, and when they want to clean it they simply wipe it off. I think that is a feature that we should all pay attention to—having clean floors.

Mr. FARNHAM: Something was said about the noise of the listening lever in the paper. In our new Boston exchange we have provided against that noise by having the lever strike upon flexible contact instead of on a solid metal base. This, I think, has proved quite an objection in the listener key—the noise caused by throwing the levers up.

In regard to dirty jacks, I suppose we need to know whether that trouble is due to the corrosion or to the dust that gets in between the springs. My opinion is that it is due to both. The question has occurred to me recently whether the lower contact of the spring might not be trimmed with German silver as well as the spring itself. We have adopted the German silver spring. Would it not be a sufficient improvement and guard against corrosion if we use German silver there? Brass, we know, is subject to more corrosion than German silver.

There was a suggestion made two or three years ago in regard to freeing the switchboards from dust, which I think has not yet been adopted, and that is to case up the switchboard on the back and supply a gentle current of air so that it would always be outward through all the crevices of the board, and dust kept out in that way. Then any little dust circulating in the room would never be thrown into the board but would be kept out.

Mr. WILSON: It is a fact that the main office in Chicago is very near the river, and the steamers going up and down the river emit a good deal of soot and smoke, which comes into our office; but we find a great deal of difficulty in all the small spring jacks that have been reduced in size during the last few years for large switchboards, and we don't find any trouble with any of the old jacks. All the new jacks have German silver springs. The difficulty seems to arise entirely from dust and dirt. The moisture in the atmosphere clings to the spring jacks, and the dust more readily adheres. The only relief for that that I have ever been able to discover is to have an inverted contact point; that is, inverted in the way we introduce the spring jack. The difficulty is very pronounced, and, if the difficulty we have in Chicago is uniformly the same throughout, I think it would be worth the while of the convention to ask the manufacturers to do something to relieve us from the trouble. If nothing can be done, why, I don't see any use in discussing the subject any further.

Dr. CULBERTSON: We have 12,352 jacks in use, and during the months from January to July we had 27 points of dirty contact. As to cords, we are using the double cord, and we have more trouble in proportion. We had running from 43 to 94 per month—making a total of 387 cord troubles. We had a total of difficulties during the seven months, of jacks, cords, transmitter and telephone and connecting cords, and key troubles, of 636. Our key troubles alone amounted to 202. They were mostly from dirty points of contact. We have the Warner key on our board. Now, while this trouble doesn't affect the Brooklyn board, our board has been in use only two years, and during the most of this time we have been putting in a new section and making changes in our key board, and that probably has been quite a source of trouble, because the general care of the board has been to some extent neglected. The Brooklyn board is entirely new, having been finished in March, I think, and besides, Brooklyn is a much cleaner city. When that board gets older, it is a question whether they won't have some of the same trouble that now afflicts others.

Mr. BARTON: I desire to bring the attention of the Association for a moment to the general question of two cords or one cord. The question of spring jack contacts is an important one, and it will require attention from members of the Association in the future as well as from those who have to do with the manufacture of the boards. I do not wish to say anything to abate the satisfaction of our Brooklyn friends with their switchboard. There is nothing that I could say that would avail to lessen their satisfaction with it. (Laughter.) I wish to draw attention, however, to the fact that it does not follow because they had a certain number of troubles with their single-cord board and a certain less number with their two-cord board that the troubles, or absence of troubles, are due to the single cord or the double cord. The fact is that the single-cord board which was put in in Brooklyn had key tables in which the apparatus was considerably crude in detail, and the difficulties as I have read in the report which was presented at Minneapolis last year were very largely due to the crudeness in the detail of that board. Now, if Mr. McKinstry, in his Cleveland single-cord board, has as many troubles with the subscriber as they had in Brooklyn, why, then there would be a chance to make a comparison of the systems, because between the time when the Brooklyn exchange was equipped and that of Cleveland there was a good deal of advancement made in the details of construction. The proper way to reach a clean base on statistics of trouble would be to compare the present Cleveland board with the present Milwaukee board, or the Thirty-eight Street, New York, board, or the board that has just been opened in Denver. The Cleveland board embodies a pretty good degree of excellence in details of construction. The same degree of excellence has been applied in the single-cord boards in use by the German government in Berlin, and those boards I think are fairly satisfactory.

I do not propose to enter into a general discussion of the advantages of the single or double cord, as it is a very large question, and there are a great many things to be said both ways. The present tendency of the judgment of the experts in this country is in favor of the two-cord key table, but I do not think that should be entirely on account of the trouble to be found with either system of key table, because those troubles depend largely on the perfection in planning and in the manufacture of the apparatus, and the real question as between single and double cords relates to other considerations.

In answer to the question of a gentleman here awhile ago as to whether there are any single-cord boards in use in the United States, I would say that there are a considerable number of such boards, among others the principal exchanges in Cleveland, one in Cincinnati, one in Providence, one in Columbus, one in Portland, Ore.; one in St. Joe, Mo.; one in Topeka, one in Los Angeles, and, perhaps, still others which don't occur to me at this moment. Those boards are tolerably well liked, I think, by those who have them. There is, so far as I know, however, with the exception of the one which has been mentioned as in use, in a certain sense, experimentally in Chicago—that is, for the purposes of trying it—there is no switchboard on the single-cord system and with the best equipment for metallic circuits.

Mr. HIBBARD: I think it would appear from what has gone before that Mr. Barton's very last remark covered the whole question. As I remember it, the prime reason for changing the Brooklyn board was, not that it had been ordered out of operation, as it was then in operation, but that it might be enlarged and made capable of having metallic lines instead of individual wires. So far as I have heard, the only reason that Chicago takes the double-cord system is the fact that the detail of handling metallic lines has not been worked out in its application to the other systems. I think Mr. Wilson was as firmly wedded to the other board then as anybody is now. I don't think his record of troubles in his main office shows that there is any inherent difficulty in operating on that plan. However, in order to change his system, and to put his wires into cables, and operate metallic instead of grounded lines, it is my opinion that they have been obliged to take these other systems. Therefore, a comparison of the system which is applicable only to the old method of operation is a question which is not in the discussion.

A MEMBER: Mr. Wilson expects to handle grounded circuit wires also with his circuit, doesn't he?

Mr. HIBBARD: Yes, sir.

Mr. WILSON: I would say that we have in Chicago nine offices, all of good size. Our largest office accommodates 3,000 subscribers. The switchboard is filled out and we have started an annex office that has now 250 subscribers, and we are waiting for additional equipment. Of course, in putting in additional equipment, we are providing for metallic circuits. At the time the switchboard was constructed in the main office there was no metallic switchboard which we were willing to accept. We have been experimenting with a view of altering over the switchboard for metallic circuits. It is not a very considerable job to do it. In deciding upon a new system, the points of excellence between the different systems to be considered were principally those of contact. The system which had the lesser number of contacts in the circuit and had the most workmanlike apparatus, for which we depend on the manufacturer, was the one adopted. In regard to the comparison of our one-cord switchboard with the Brooklyn board, I will say that the principal objection, which I understand was made to the Brooklyn board, was this: that if a cord became out of order the subscriber's line was temporarily interrupted. In the Chicago board that was not the case, and in that sense the Chicago board is not, strictly speaking, a one-cord board. It has the one-cord feature, which is the primary feature of the board, but we also have enough double cords overhead to relieve that one cord when it becomes out of order, and we have never had that difficulty. It is a very simple thing for the operator to discover when the cord is broken. Then he will simply tie the cord in a knot and hang it up above the operator and use the overhead cord. We never considered that the one-cord board without a few overhead cords was a good thing. The answering is done by the insertion of a plug in the spring jack. We consider the spring jack the best thing of mechanism that we had at that time. When we could substitute a spring jack for a cantilever key we did so. Aside from our dirty spring jack, we had less trouble in proportion to the size of that switchboard than any board I knew anything about in the country, but when we undertook to change our system to metallic circuits we considered the same features that we did when we put in the one-cord switchboard. We found that the one-cord metallic circuit switchboard had more contacts in it than the two-cord system which we adopted. From experience we have formed a prejudice against cam lever keys, and we don't propose to use any. We have a new key that goes into the board like a spring jack. It has all the features of a spring jack in it. We have had those keys in operation now for over six months, and never had a single case of trouble with them. We have had the Thirty-eighth street system in operation alongside of the system which we have adopted, and we think that our experience is positive enough to adopt what we call the Chicago system.

Mr. LOCKWOOD: In addition to the present inapplicability of the single cord, it seems to me that there is one other consideration which Mr. Wilson has hinted at when he says that if a cord gives out they would knot it and leave it out of use for the present and use the overhead cord. It appears then that the most fragile portion of their circuit is a portion of every line with single-cord boards, while it is only a series of links in the double-cord switchboard. That of itself seems to me to be a consideration which should weigh very heavily with all in considering the matter. There is also a word about the location of exchanges on the Eastern seaboard that I would mention. One of the greatest troubles is the moist and saline condition of the atmosphere, which of course brings in quite a different class of trouble than in Western cities where they burn soft coal. That material which seems to interpose itself in the contact system in the Western cities is carbon that floats in the atmosphere. It was my fortune to be able to prove that in a remarkable way at one time. I had to stop over some hours at a little station on the Erie railway, and I went into the telephone office and in the course of some conversation with the operator he said there was one line that wouldn't work. I looked at it, and I loosened the spring jack down a little, and I found I could actually use it as a transmitter, there was so much carbon between the points.

Now, I have found another trouble with spring jacks. Some months ago I had occasion to spend a couple of days in Albany, and I found that one of the spring jack troubles there was not dirt or carbon between the points, and it struck me that perhaps much which has been ascribed to dirt was really due to the trouble they had there, namely, that the insulated contact screw in the lower part of the jack had been made with such a sharp point that it made a dent in the screw in the spring above, and by and by that depression was made so deep that when the foot was taken out it was all that the spring would do to make contact with the screw point at all. This of course depends largely upon the material used, and in this case I may say that the material was not brass, but it was German silver, and, as there are different grades of German silver, of course we should be careful and get the proper grade.

The vice-president again took the chair.

The PRESIDENT: Referring to Mr. Wilson's question, I would remark that I think that the troubles referred to are the troubles in connecting the wires with the subscribers. There is a rigid system of inspection at regular intervals with all parts of the apparatus in Brooklyn. In regard to the change from single to double cord switchboards, the change was made not on account of the large amount of trouble, but on account of the former not being adapted to the mixed system of metallic and grounded wires, so the present key-board was put in to accommodate that system. Our metallic system is increasing very largely. I will say that I have introduced this paper for the very purpose of contrasting the two systems, and to bring out the faults that they may have had, and endeavored to get the very best result. The key-board is the most important part of the switchboard. It is a part that is in constant use and wear, and needs constant watching, and requires renewal very frequently.

In regard to the dirt between the contacts of the spring jacks I have no doubt that climatic conditions do affect the spring jacks to a very great degree, so that different cities will observe different results with the same apparatus. I think also that it is better in all large central offices to have a hard wood floor. It can be more easily kept clean. I think it is much better than a carpet or even linoleum, because there is less chance for dust to accumulate. We have never had any carpet or rugs in our operating rooms.

The opinion we have formed by trial of the two key-boards is that, taking all the conditions of the business, the double-cord system is essentially the best; that with the single-cord system, doing the best you can, it is so crowded and it is so difficult to remedy trouble, occurring in the midst of busy hours, that this fact alone is enough to condemn it. Mr. Wilson's recommendation of the single-cord board is something like that of the cripple who had become very expert with his crutches, which in this case are double cords, which he used when the single cord failed; but no cripple would be willing to continue the use of his crutches if he could use his legs. I do not think anybody wants to use a single-cord board if they have got to have a double auxiliary key-board to keep it on its legs.

Mr. WILSON: I have got to defend myself again. I do not entirely agree with President Sargent that the single-cord board is to be considered in the light of a cripple, although it is now in the light of a metallic circuit. The advantages, we say, in favor of the single-cord system are just as apparent to-day as they ever were. In the first place, you have to have half the number of cords in use. Instead of using two cords to make connection you use one. The great advantage is, for instance, that we have a case of cord trouble reported, and we know exactly where to find the cord, which you do not know in the case of a two-cord board. For instance, if you have a defective cord, and it is not sufficiently defective so that the operator discovers it when she rings, why, that interruption will pass around over half a dozen or, perhaps, 20 subscribers before it is discovered. You get a complaint in the office of cutting off and unsatisfactory service, and you know from the nature of the complaint that the trouble is in the cord. Well, you get the number of subscribers that are connected in that particular complaint, and you know then which group of cords was used, and you examine them and see if you can find the trouble. But you may not be able to find it, especially if you use tinsel cord. Now, with the one-cord system, if we get a complaint of that kind we cut the cord off and repair it, whether we find the trouble or not, and in nine cases out of ten if an examination is made carefully the trouble is found largely in favor of the one-cord system. But I do not want to be understood as advocating the one-cord system for metallic circuits, because I am not. But if I was going to equip a new office, which I am doing all the time in our small exchanges, why I would use the one-cord system. We use the one-cord system altogether for metallic circuits in small exchanges where we have multiple switchboards. The advantages are, that we equip those switchboards just as we add subscribers. For instance, we have a small exchange with 10 or 15 subscribers. We add the complete equipment for each subscriber. We keep run of the cord. If the cord becomes defective in those switchboards, we simply use the other cord, and we have the same advantage as we have in our main office with the two cords that are used in emergencies. We are increasing the number of our private exchanges in Chicago rapidly—that is, a sort of combination of speaking tubes—and we use what we call the single-cord system. Every subscriber's line has a cord. It is double cord, in the sense that it is arranged in a metallic circuit, but the two cords are under one cover and have only one plug; and we think we can see advantages in it. It is the cleanest and nicest equipment that we have with any cam

lever keys, or anything of that sort, and wherever we have those small switchboards in operation they give complete satisfaction.

In case some gentlemen here may not understand what I mean by private exchanges, I will say that we have quite a number of subscribers—like, for instance, the Illinois Steel Company, which has its general office in Chicago with about 20 telephones in use; this company has three rolling mills in and around the city and has lines connecting them, and we run all those lines into the private exchange located in the general office, and we provide three trunk lines from that switchboard into our office. We call that a private exchange. We make them a special rate, of course, for that service, and then the telephones in their general office are connected in such a way that they have what we call the speaking-tube service. That is, they don't have to call their operator to get that service. We are putting in quite a good many of those outfits. Armour & Co. have one like that. The Milwaukee & St. Paul Railroad Company has one, and we are now connecting the Wisconsin Central Railroad main office with all its branch offices in the city. The subscriber in such cases as these becomes our company's agent in the transaction of that business, and the deduction they get in rates is in compensation we pay them for handling the work. They pay regular rates for everything and we pay them so much for operating the private exchange. In all those places we use the one-cord system, and prefer it to the two-cord system. If I were going to equip a large exchange with metallic circuits I would use the two-cord system.

Mr. E. J. HALL, JR.: I think, Mr. President, that we have some time ago passed the hour for adjournment for dinner, and accordingly I move that we adjourn.

The convention then adjourned until 2 o'clock.

SECOND SESSION.

The PRESIDENT: Gentlemen will please come to order.

Mr. EASTERBROOK: Is there any regular order of business at this time?

The PRESIDENT: No, sir; except the reading of papers.

Mr. EASTERBROOK: Then I would move at this time that the opening of to-morrow morning's session be the time designated for the choice of a place for holding our next annual meeting, as I believe it is only fair that any interests to be heard should have warning at what time that matter will come up.

The motion was duly seconded and carried.

The PRESIDENT: There being no other motion to discuss, we will proceed to the reading of a paper by Mr. E. J. Hall, Jr., on the subject of "Corporate Organization."

Mr. Hall then read his paper, which was as follows:

CORPORATE ORGANIZATION.

Corporations have been called "artificial persons," owing their existence to the creative power of the State, and designed by process of law with more or less skill to approximate natural persons in their powers and duties. When the legislative powers are exercised wisely and skillfully, and these artificial persons have been properly constructed, they take their place in society as most useful members, serving the needs of the public in many ways with far greater efficiency and reliability than any natural persons possibly could; for while it may be true that corporations have no souls, it is equally true that they are not subject to paralysis or indigestion. On the other hand, their design being subject to the fancy of legislative bodies, these artificial persons are sometimes over-developed in some directions and lacking in others—the builder who follows the legal specifications often finding that parts essential to some material function are wholly omitted, while others are so dwarfed or magnified as to be out of proportion to the symmetry of the intended design.

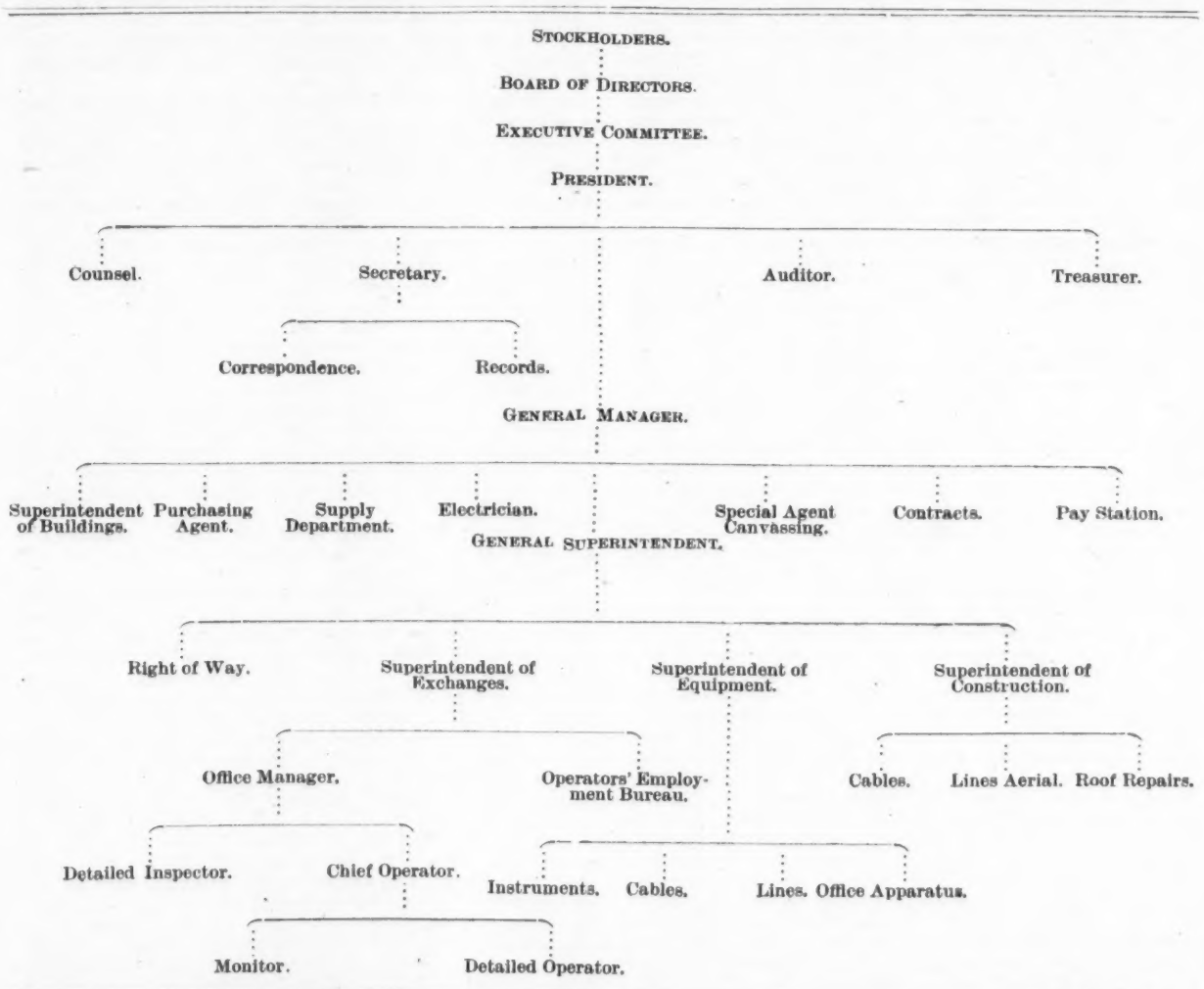
In the early days of these new members of society the natural persons then composing it had a feeling of, perhaps, not unnatural alarm that if these artificial persons became too big or too numerous they might be troublesome neighbors. What, for instance, if the power which gave them legs and arms should take a notion to add cloven feet, horns and a tail? This has, from time to time occasioned the introduction of various restrictions into the specifications, some of them doubtless wise, others unquestionably unwise, but with a realization of the fact that society had not lost and could not lose the power to protect itself, has come to a better understanding of the benefits to be derived from properly constructed corporations and a disposition to formulate the specifications so that their construction shall be encouraged and their capacity for work utilized to the fullest extent by society.

The tone of the press during the recent labor troubles on the New York Central Railroad reflects a marked change in public sentiment from that existing even a few years ago, and, to some extent, this change is due to a better understanding on the part of corporation managers of the obligations which rest on them to so organize their forces that the public shall be efficiently served, stockholders receive proper returns, and last, but by no means least, that employés shall be justly compensated and fairly treated. To organize and conduct a corporation so as to fully meet all these obligations is no easy task. In my own work I have been greatly helped by making diagrams of any proposed arrangement of forces, for the purpose of studying from that the exact relations which would exist between various departments and employés if the plan were carried into effect. Almost invariably the study of a diagram brings out unexpected defects of arrangement or suggests changes which would improve the efficiency of the force. President Sargent has asked me to explain this diagram system, and I am glad to comply with his request, because I believe there is for us no more vital problem than the best method of constructing the "artificial persons" who are furnishing the public with its telephone service, but for whose actions we are all largely responsible.

I do not see why we should not go at this just as we would at the construction of any piece of mechanism. Surely it is more complicated and more delicate than any of our electrical apparatus, and, at the same time, its motions are attended with such consequences that we cannot afford to make any mistake. When we undertake to prepare plans and specifications for the construction of an "artificial person" to conduct the business of a telephone exchange, we must look, first, to the statutes of the State, in which we will find the legal specifications. From them are prepared the charter, articles of incorporation, which, in a general way, define the nature of the proposed corporation and the position which it desires to occupy in relation to the State, while the by-laws, which are to some extent controlled by statute, provide, generally, for the relations of the corporation with its stockholders. By the articles of incorporation and the by-laws provision is made for the control of the corporation by trustees or directors elected by the stockholders, and by certain officers, usually a president, secretary and treasurer, elected either by the stockholders or by the directors. These officers are common to all corporations, and are charged with certain duties by the State and by the by-laws. It would be interesting to go more fully into the relations thus established between the new corporation, the State which gives it being and the stockholders who risk their fortunes on its success. We will not, however, stop to do so now, because we are considering to-day only the executive forces, the *physical structure* of our "artificial persons." The functions of the officers named will be considered only as they relate to the performance of the work for which the forces are to be organized.

The unit of work, that is, the amount which can be performed by one person, is very small, so we must subdivide until each part of our work receives its proper share of attention; but, as all of the parts are inter-related, it is evident that there must be somewhere a single central authority, for the division means chaos. From this central authority there must be a direct line of communication to every department and every employé; no matter how many departments or employés there may be, this line must be kept in good working order, free at all times from breaks and crosses. To carry our simile of the artificial person a little further: When in a natural person the stomach wires the brain for supplies, the feet must receive orders to move toward them, first one, then the other; they cannot be left to argue between themselves as to which shall move first; then the hands must do their work and, at the right moment, the mouth must be ready to do its part, and so each member performs its office as the orders are sent over the connecting lines, and reports from each keep the brain constantly advised of the manner in which its instructions are being carried out.

To construct a diagram of these lines of communication will help us to see how best to arrange the various parts of



our artificial person to secure as exact results. For convenience we will call this main line the "line of authority," and extend it unbroken from the management to each employé. Other lines there may be and must be to unite all the parts of our mechanism into a complete working body, but they must never be mistaken for or tangled with the line of authority or confusion will follow. On the diagram which I have made we can trace now the line of authority originating with the stockholders, extending to the board of directors, then to the president, then to the general manager, and, dividing at that point, branches extend to each department chief, and through him to his subordinate officers, superintendents, managers, foreman and so on until it reaches the last messenger boy.

The general office is particularly the department of the general manager. Its work consists, *first*, in receiving and recording the orders of the president and directors and transmitting them to the proper persons for execution. With the orders must go the funds and materials for carrying them into effect and the details of the methods to be followed; *second*, to the general office must come back the reports and results of all work, which must be recorded and transmitted in proper shape to the directors; *third*, through the general office all arrangements must be made for *transfers* from one department to another.

The general manager acts as the connecting link between the authority which shapes the plans and controls the policy of the company and forces which carry those plans into effect. He should be identified as closely as possible with both, and this is often accomplished by making him a member of the board of directors, thus enabling him to fully understand the nature of the results to be accomplished, while, at the same time, his close relations with the working forces enable him to keep the directors fully informed as to the condition of the company's p nt and forces, their possibilities and needs for accomplishment of any desired result. The general manager, as the diagram shows, has no authority over the secretary, treasurer, auditor, or any employé on the president's line, but such relations as are necessary must be established by order of the directors or the president, unless, as is often the case, the general manager is also vice-president, in which case his relations are established by the *latter position*. This distinction is important, and it applies equally in the case of all relations between officers and employés of different grades when one person fills two offices not on the same "line of authority."

The general manager should be responsible for the appointment of all employés on his staff or below it, but it does not by any means follow that he should in person select all individuals for appointment; on the contrary, holding a veto power over all, he should select none but his personal assistants and the heads of the departments, for the same reason which makes it necessary for him to control all appointments makes it necessary that—following the line of authority and conversely of responsibility—each other officer should, so far as possible, hire and discharge all for whose efficiency he is immediately responsible.

Just here I want to point out the error into which all of us who have charge of a number of men are apt to fall: That is, of doing too much detail work—too much *work* I was about to say, but it is the quality not the quantity generally at fault. It is often so much easier to do personally than it is to teach others that we fall, often unsensibly, into the error of doing routine work which others can do as well or better; and having filled our day with arduous labor, go home at night tired, but satisfied that the day has been well spent, when, as a matter of fact, we have perhaps lost sight of our duty to keep track of and direct the work of others, and have performed the work of a junior clerk, while the interests committed to our charge have suffered in all directions from neglect.

The functions of the construction and operating departments with their various sub-divisions are so well understood by all that it is unnecessary to go into details, and we will follow quickly along the line of authority through the office of the general superintendent to the linemen on one side and on the other to the operator and messengers. Now, to pass from one point of the diagram to another we must follow back and around on the established lines. There must be no cross lines of authority established, or immediately there is a division of responsibility. This does not mean that there are to be no direct relations between officers and departments except over the route of lines of authority. On the contrary, as I have already said, there must be almost innumerable "lines of relation." These lines may be established in two ways. First, by order of some common superior authority, and second, by an understanding between the employés concerned. For instance, by order of the president, the treasurer might be authorized to use office managers to collect certain accounts or pay certain bills. The treasurer would then have a line of direct relation established with each office manager, but the authority would originate with the president, and his order would pass through the hands of the general manager, general superintendent and superintendent of exchanges to the office managers. Authority given to the treasurer to employ the managers would always be given with the tacit or expressed understanding that the regular duties of the employé called on should not be interfered with, and that the employé's first duty was in every case to his immediate superior.

As an instance of the second sort, it might be arranged between the construction department and the equipment department that one would do certain things in connection with the other's work; for example, that the equipment department would hang a cable which the construction department was responsible for hanging. The test of this transaction would come in case of failure to carry out this understanding. Would it be any excuse for the superintendent of construction to say that the superintendent of equipment had promised to hang the cable and had failed to do it? Clearly not. The diagram shows how such an arrangement could have been made by authority. He took the chances of an arrangement under which he had no control over the other party and he accepted all the responsibility. In a bad organization this constant shift-

ing of responsibility is always found, and the blame should be with the organizers rather than with the employés, who are probably doing the best they can with the faulty system.

Another fault always found in a bad organization is a defective method of giving orders. Sometimes an organization that otherwise would be good is demoralized in its work by a careless habit of giving vague verbal orders, a practice sure to result in confusion. Whenever practicable, orders should be given in writing; they should be brief and clear, and whatever is to be left to the discretion of a person carrying out an order should, if possible, be so stated. Advice and suggestions may be verbal, and often are better so. When an order is accompanied by advice or suggestions as to methods, care should be taken to so separate the order and the suggestions that there may be no misunderstanding. When verbal orders of any importance are received by any employé he should take the earliest opportunity to reduce them to writing and send an acknowledgment of them, explaining his understanding of their nature, to the officer from whom they were received.

The chart which I have made shows substantially the general organization of a large company, but one which operates a comparatively small territory. Of course a chart prepared for one telephone company or exchange would not be suitable for all others, or, perhaps, for any other; but there are certain functions which are common to all and modifications can easily be made to fit all conditions.

The key-note of all successful organizations is sounded in the Bible words: "No man can serve two masters." In the abstract we doubtless all agree with this, but in practice we often make discord instead of harmony among the delicate strings which bind our forces together. It is easy to say that we all arrange our forces so that no man shall serve two masters, but it is far from easy to do it. Especially is it difficult in a small company where the number of men must necessarily be limited, but where the mansfold duties of the service must still all be performed. Even in the larger organizations it is far easier to cross and tangle the lines than it is to keep them straight. The diagram system will aid the manager of a small company to arrange his men to advantage, while to the manager of a large company it will act like the "deadly parallel column" in the newspaper, pointing out all inconsistencies between theory and practice.

Our work of organization and adminstration is, under the most favorable conditions, perplexing and difficult. Lines must be built, offices equipped, apparatus designed and constructed, records kept, rights of way obtained, reports made, supplies purchased and taken care of, problems---legal, financial, scientific and practical---solved, and withal we must reckon with human nature in all its varied forms. Each unit of the vast aggregation must be placed where it will be most beneficial to the whole and yet each be so dealt with that personal pride and self-interest shall be considered, faithful service and capacity duly rewarded, the ignorant educated, the idle punished, the vicious and incapable eliminated, and over all strict discipline, tempered with sympathy and kindness, maintained. Only a thorough organization, wisely administered, can accomplish all this. Without organization the ablest will fail and with it the best will often fall far short of their ideal. When we have constructed our "artificial persons" from drawings which clearly show the location and relations of all the parts and from specifications which define in exact language the function of each, it may still lack much of the perfection of the natural person, but I am sure it will do its work with far more efficiency and vastly less disturbance than if it be simply an aggregation of unrelated parts tangled together by the old-fashioned "rule of thumb" method.

The PRESIDENT: Gentlemen, you have listened to the reading of the paper by Mr. Hall. Are there any remarks?

Mr. HALL: While this diagram is applicable to the general organization of a company, I ask Mr. Carty, who is interested in this, to make a diagram showing how he, in following out this line of thought, has organized the department for which he is responsible in his own company; and, starting in here (indicating), as you see, at the "Superintendent of Equipment" in the general scheme, he has arranged a diagram of the force which he has under his control, and I think it would be interesting to have him explain how he has utilized this idea before we take up the matter for general discussion.

Mr. EASTERBROOK: Before proceeding to that I move that Mr. Hall's paper be accepted with thanks, and printed in the proceedings of the Association.

The motion was duly seconded and carried.

Mr. CARTY: This diagram on the wall represents one of the departments of the Metropolitan Telephone Company. The superintendent of equipment is responsible for the condition of the plant. Any trouble with the wires, cable or apparatus in a subscriber's office, or in a central office, comes from here (indicating). This is the chief inspector here (indicating), and he has under him, first, a foreman inspector, who gives out the daily work to the inspectors who visit the subscribers' stations. The duty of an inspector is to go to a station and see that it is in order, make a note of what condition he finds it in, and what he has done, and hand to the subscriber a printed slip which has on it a request for the subscriber to inscribe on the back of the slip any fault he may have to find. This foreman inspector has a large detail of men under him, and he is responsible for seeing that his men do their work properly. Then for taking care of the trouble there is located at each of the various offices what is called a "wire chief." For instance, at Cortlandt street we have a man who sits at a desk called the "trouble desk," and who is equipped with all the necessary apparatus for locating the trouble. If the trouble at any one of the various stations becomes greater than the ordinary staff can properly take care of, the wire chief at that station communicates with the chief inspector, and the detail is increased; or, on the contrary, if he gets his work up in a good shape, he reports that fact and the men are transferred somewhere else. The chief wireman receives from the general superintendent the orders to put in an instrument for a new subscriber, and that order is turned over to the chief wireman, who gives it to his foreman, and the job is assigned to a particular workman. The chief wireman also sees that the line is cut in at the cable terminal and at the subscriber's station. So that the task of getting the line working is in the hands of one man, and when the line is connected up in working order the chief lineman sends the order back through the superintendent of equipment to the general superintendent, and a record of it is made on the books. When a new subscriber is put in at Thirty-eighth street, the representative of the equipment department there has got the receipt for information connected with that subscriber. For instance, he has to receive a slip and take a note of the cable conductor that that subscriber occupies, and all the other data necessary to go into the record. So that at Thirty-eight street there is a complete record of all the terminals terminating there and all the subscribers, and no change can take place without going through the Thirty-eight street wire chief. A similar record is kept at each of the branch offices and a record of the entire city is kept by the superintendent of equipment.

This scheme is not thoroughly completed in New York, but as far as we have got it has been of the very greatest assistance. It completely divorced from the operating department all responsibility for the plant. If the trouble should occur to a subscriber's office in the Thirty-eighth street station, a notice of that would find its way to the office of the general manager, and he would forward it to the representative of the equipment department located at that office and called the wire chief. Any ordinary trouble would be first known by the superintendent of equipment as a notice that it had been attended to. An arrangement of this kind enables you to keep up records of trouble and compare one office with another and make some important savings in the number of men at each office.

Mr. BARTON: I should understand from this diagram, and from what Mr. Carty says, that the chief operator, we will say of the Spring street exchange, would have charge of the operating force—that is, of the operator who answers the subscriber who calls up a connection—but that the chief operator and the operators themselves are not in this organization at all?

Mr. CARTY: No; they are quite separate.

Mr. BARTON: They are another department?

Mr. CARTY: Yes, sir.

Mr. BARTON: Then at the Spring street exchange there is a chief operator and wire chief; one has authority over the operators, and the other has authority and control over the apparatus, and they give information from one to the other, but there is no authority passing from one to the other?

Mr. CARTY: No; there is simply a line of communication between the two. The manager of the office or the chief operator is responsible for the service of that office, and if there is any fault with the equipment department it is his duty to get it on record; but the responsibility of the plant rests with the superintendent of equipment, and is accordingly a separate matter from that of operating the switchboard.

Mr. HALL: I think perhaps I can go a little further by reference to the original diagram. Mr. Carty has taken the diagram at this point (indicating) and has shown what is done by the special division force under his charge. Now, the central thought of all that is this: that in that company one man is responsible for the condition of the line and switchboard of the company; there is one man responsible for the physical condition of the property; he has no relation with the operators or with the operating service, that is an entirely separate department, but he is responsible for the operators and the subscribers being furnished with suitable apparatus, and apparatus properly taken care of. That simplifies the problem as to who is responsible for any fault in the service. If the fault is one of apparatus or maintenance, then the superintendent of equipment is to blame. He has nothing to do with the construction of that plant, and he has nothing to do with the operation of it. The question might then be raised that, having nothing to do with the construction of a thing, it might not be properly constructed. That is possible, but his skirts are entirely clear because all he has to do is to report to the general superintendent that as a certain thing is constructed it is not possible for him to keep it in proper order. Then he is relieved from blame. The general superintendent may refer the matter to the general manager. It may or may not be possible to correct it. If it cannot be corrected, then the superintendent of equipment simply does the best he can with what is furnished him. If it can be relieved, then it becomes a question for superior authority to give proper instructions over here (indicating). In each of these offices are "detailed operators," and under the office managers are "detailed inspectors." That means that, while these men are under the office manager, he does not employ them. They are simply placed there for the purpose of receiving information as to what is to be done in their work. To illustrate, if a subscriber in the Harlem office is in trouble, the proper place for that information to go is to the superintendent of equipment, because he is responsible for it. His office is at Cortlandt street. Now, it would not be reasonable for him to send a man away up to Harlem to fix that. So, as a matter of convenience, this superintendent details a certain number of men to receive their instructions from the office of the manager at Harlem, and the manager of the office at Harlem simply informs those men that line so-and-so is in trouble, and his duties are ended when he has given them that information. The men go out, and if the man who is sent to fix it cannot do so he reports back, not to the office manager, but to his superior, the superintendent of equipment, as to what is to be done, and gets information how it is to be fixed. So that in the office of the superintendent of equipment there is a complete record kept, and it comes down to this: that I should expect Mr. Carty to be able to say at a moment's notice exactly what the history had been of any instrument in his company for any period of time under which he had had this system in operation; his records would show precisely all that had been done by every man in every department under his charge. If he has 10,000 or 15,000 stations to look after he must have a complete system of doing it, because he cannot have personal knowledge and must depend upon his records, and the only way is for the reports to come right back to him.

Mr. GIFFORD: Your superintendent of equipment does not undertake to build anything. He simply undertakes to take care of it.

Mr. HALL: Yes, sir; and that brings up another thing and that is that written specifications should be made out defining precisely what the superintendent of equipment is to do. I saw a quotation the other day which struck me as very apt on this thing, which was: that reading made a learned man, conference made a ready man, and writing made an accurate man. And that is very true. When you undertake to write the exact functions which an employé is to perform, you must be perfectly clear in your own mind what they are. I consider it essentially part of a diagram scheme that you should write out in detail just what each employé is to do.

Then there is another point about this. The forms and blanks in use are sometimes defective. Now, we had in one company an expert to go through the whole organization from the subscriber's order up to the rendering of the treasurer's bill. He determined first whether the books of the company were in such shape as should be required, and whether each man knew exactly what he had to do and whether he was supplied with records to keep account of things. And I think right here that we can say that a proper organization does not mean red tape and complications, but it means simplification. I have found that in most companies there are a vast amount of duplications, unnecessary routine. The fault does not lie in having too little, but in having too much. Now, our expert was an accountant and familiar with the general system of laying out a company. Instead of undertaking to take the blanks and forms of the company and determine which should be dropped and which continued, we simply closed the book and started out with what we thought ought to exist; we cut off here and added there until what had existed was brought into line, and we made the books fit the business. If you undertake to straighten out a company by fitting out what they have got you will never succeed. The only way to do is to start and organize as if you were beginning a new concern, and then if what you have already corresponds to that, why, all right; if something is unnecessary, omit it. The expert stated first at the "contract department," and a form of contract was prepared. Then the question of the kind of books the contract man should keep was taken up and settled. Then it was determined that the proper place where the contract should go would be to the general manager, and he accepts it on behalf of the company by placing his signature upon it. Then there is the line to build, the telephone to put in, and so forth. The general manager sends the order to the general superintendent to build the line, and that is a matter—as to how he shall build it—of internal arrangement. The superintendent of equipment has charge of the building of the line, and finally the subscriber gets his telephone service. Then all that detail is reported back through the proper windings to the general superintendent and to the general manager.

Mr. EASTERBROOK: As the long-distance company is beginning to touch the different companies, and the further it goes the more the complication arises, the matter of tolls, rates and the prorating of toll rates is becoming a very important subject. Where would you locate that, on what level and how would you reach it—under the general manager's department, or through the auditor?

Mr. HALL: The American Bell Company would fix that.

Mr. EASTERBROOK: But in the organization of any company, who should act for it with regard to that?

Mr. HALL: Any of the relations which exist between companies are ordinarily established either by the precedent or by the general managers.

Mr. EASTERBROOK: I understand that, but you have not subdivided that there. I only wanted to get your idea about that.

Mr. TYLER: Mr. Easterbrook's question would be answered by saying that the matter should be settled just as each individual company would be willing to do it for their company.

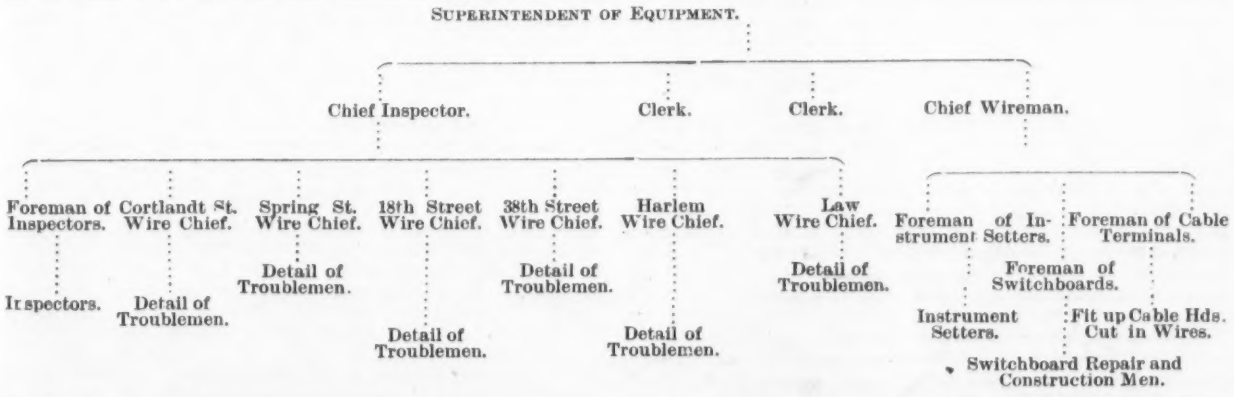
Mr. HALL: My idea would be that it should go to the general manager.

A MEMBER: The general manager of any company won't have much to say about the American Bell Telephone Company's rates. (Laughter.)

Mr. EASTERBROOK: No, I know that.

Mr. HALL: There has been a suggestion made that the faults of an organization come generally from those high in authority in it rather than from the subordinates. That is very often so. For instance, the president may have personal knowledge of something wrong and he comes straight across and tells the superintendent of construction that he must do this or that. Now, that is fatal to a proper organization. It is something the president should never do except in an extreme case. Of course, he has a right to do it, but when he does it he relieves the general manager and the general superintendent of all responsibility. So that while it is right he should do that, it is a right that should be exercised very rarely. He ought to notify his general superintendent about it and let the order be transmitted through the proper channel.

Mr. LOCKWOOD: I feel like saying that so far as we have gone this meeting seems to be one of the most in-



structive and profitable that we have had for some years. This matter of proper authority and the proper delegation of authority is one of great consequence. Prior to my present employment I was for six or seven years with different electrical companies, and I think I may say that there was but one of them which was properly organized. Where there is defective organization there will always be conflict of authority. The company I refer to was the American District Telegraph Company of New York. It started out under the superintendence of Mr. Shaughness, and then Mr. William H. Sawyer was the second general superintenden , and he was followed by Mr. Durant, now of St. Louis, and H. W. Pope; but it was under Mr. Pope that the organization was perfected. The conflict of authority was fatal to good work. Where every man's position is strictly defined he knows he cannot tread upon anybody's toes. Following out the line that Mr. Hall referred to last, it has often come to my knowledge that a president or general manager, ignoring all intermediate channels, will meet some office manager or some lineman perhaps, and will say that such a line is out of order, why don't you fix it? or will give absolute orders, and the office manager or the lineman is bound of course to carry out those instructions; but frequently, if he does so, and if he doesn't carry the information on the back-track to his intermediate superior, there will be at once hard feelings generated on the part of those men who quite unwarrantably will assume that this man had no business to carry out orders except they were given through the proper channel. It would also be a pleasant thing for this subordinate to say to the president, "I will do so and so, and I shall also speak to my general superintendent about it." By so doing he will convey a delicate lesson and not cause any hard feeling, and ten to one the president who gives him the order will say, "Certainly, I wish you to do it, but I wish you to do it in the right way."

On motion the convention adjourned until the following day at 10 A. M.

THIRD SESSION.

The PRESIDENT: The first business this morning is the selection of a place for our next meeting. Nominations are now in order.

Mr. CRANDALL: I believe it was generally understood at our last meeting in Minneapolis that New Orleans would be selected at this meeting for 1891. I hope there has been no change in the opinion of members since then, as I can assure you that we all heartily desire to have this association meet there next year. I have received assurances from the older members of their desire to go there; many of them have inquired whether the girls were as pretty in New Orleans as I stated at our last annual meeting they were, and upon reassuring them of the truth of that statement, they have determined to stand by me anyhow, and I hope the younger men will, too (laughter), and if you will come down there I am satisfied that you won't be disappointed. I would suggest, however, that the date of meeting should be left to the Executive Committee. I therefore place in nomination the city of New Orleans as the next place of meeting, and hope it will not have any opposition—not that I expect that it will be defeated, but simply because I don't want to antagonize any of my friends.

Mr. E. J. HALL, Sr.: I feel quite sure you will talk me down; but you will recollect that last year Buffalo put in a bid for this convention which was afterwards withdrawn in favor of Detroit. I rise to state that that invitation is still open. I do not know how much caucusing Mr. Crandall has done for New Orleans. I have not done any. (Laughter.)

Mr. CRANDALL: I would remark that I know that this is all spontaneous on the part of my friend Mr. Hall, from the great bump of hospitality there is in him. He is one of the men who has been talking to me about pretty girls, and saying he wanted to go to New Orleans. (Laughter.)

The PRESIDENT: The chair would announce that he has received a letter from the proprietor of the Hotel Stockton, at Cape May, suggesting that this Association meet there in either 1891 or 1892. I don't know that the letter requires any action on the part of the Association, but I simply mention the fact that such a letter has been received.

Mr. EASTERBROOK: In order to get the sense of the house, I move that the invitation from New Orleans as a place for our next annual meeting be accepted, and that the time for the meeting be left with the Executive Committee to determine. I may state that my personal reasons for wishing to go there is, that I like red snapper better than lake whitefish. (Laughter.)

The motion was duly seconded, and carried unanimously.

The PRESIDENT: The next business is the reading of papers. Mr. W. F. Patterson, of Chicago, will read a paper on "The Housing and Care of Central Office Apparatus."

Mr. Patterson then read his paper, as follows:

THE HOUSING AND CARE OF CENTRAL OFFICE APPARATUS.

The cost of the apparatus in a large central office is often greater than the cost of the building which contains it; at the least, it is equal to a very considerable fraction of the cost of the building. In renting an operating room for a short term, there may be some excuse for taking things as they are found and working the exchange at a disadvantage in some particulars; but when a special building is to be erected, nominally as a telephone exchange building, it must be something more than an office building with the most undesirable part grudgingly spared for an operating room. An outside income from rental of offices and stores is a good thing, unless it is secured at the expense of the legitimate business of the company. The switching apparatus of an exchange system is not a lot of separate instruments, like the outfit of a telegraph office, but it is a complex entity which requires weeks or months to put in position and the parts of which are not easily renewable or accessible. Therefore, in planning the construction of a building the fact must not be lost sight of that it is a telephone building, and that its purpose is to protect the central office apparatus and facilitate economical and satisfactory service.

In planning a new building the company's electrician is to be consulted before the architect. The electrician's duty is to plan a switchboard room with reference to the best possible arrangement of the board and all the apparatus connected therewith, having as the only limitation the size and shape of the building lot. The process of evolution of the building must be, first, the switchboard with its accessories; second, the finished rooms to contain them; third, the building of which these rooms form a part. At the third stage, and not till then, except as a consulting engineer, should the architect be called in. Give him the building lot and the finished operating room and its complete equipment as his limitations, and then let him do the best he can with the building.

As to the location of the operating room in the building, precedent is for the top floor. When all the wires were on poles and housetops, the most convenient place for the switchboard was at the top of the building. The use of underground wires is almost universal, at least for leading in from neighboring poles, and this would suggest that a more advantageous place might be found in the lower part of the building. It is impracticable to lay down any hard and fast law, but it would seem that the use of the first or second floor for an operating room was worth considering. Financially, the problem is whether the rental value of the top story, plus the rental value of the space occupied in each story by the cables leading in, plus the interest and depreciation on such cables, is greater or less than the rental value of the first or second floor. In case of a building covering an entire lot the advantages of an operating room on a lower floor are not so obvious, but in a large building where an interior or rear court is left for light, the operating room may economically be placed on the second floor; building up the court two stories instead of one, and using the rear of the basement and first floors for storage, so that, for example, the room taken for the exchange room would be in the rear of the second story as against the whole of the top story. Of course, this is only an illustration of what might be done in one case.

Electrically, everything is in favor of an operating room near the ground, when, as is the general practice, underground cables are used. One or two hundred feet of cable made a permanent part of every circuit is in itself of no importance; but in large cities the amount of cable absolutely required elsewhere and the possibilities of long distance work with connections into and through other cities, make it important to cut the amount of cable down to what must be used.

All these things, and many others which local conditions impose, being considered and the operating room planned and its position in the building determined, the next points for consideration are: Getting the switchboard and other apparatus into the room; connecting the switchboard with the underground conduits; heating, lighting and ventilating the operating room, and protecting it and its contents from fire. Providing means for getting in and out with apparatus must be considered. In making plans, the best way is to project into space the switchboard, then project around it an operating room and then fill in the rest with the best arrangement of rooms and offices. But in building, the process must be reversed,—first, the building, then finish the operating room, and last of all put in its furniture.

Dragging switchboard sections into an unfinished building through a window or a hole left in the wall is poor policy. While the ultimate end of any machine is the junk shop, a piece of work like a switchboard makes more progress toward that end in a few weeks in an unfinished building than in years of service. Provision must be made for getting cables from the street conduit to the switchboard. The position of the building relative to the conduit and the number of cables to be accommodated will determine the best way of getting from the conduit into the building. In general, a tunnel accessible throughout its whole length is best. If the cables are to be taken up through the building to an operating room, on the top floor, there are several ways of getting them there. One is through ducts built in the wall; another through pipes fastened to the walls, either inside or outside; another is through a shaft or well-hole in which the cables are accessible. Whichever plan is adopted it should be carried out in such a way that cables of as good specifications as the regular underground cables can be used. In general, the shaft is the best plan, then the pipes on the walls, and least satisfactory the system of small flues in the walls. The shaft is of advantage not only in handling cables, but also as a ventilator for the conduit. A good plan for a large exchange, to require a hundred or more cables, is a straight tunnel or passage-way through the building from the conduit in the street to a point under the cable terminal room. From the inner end of this tunnel a straight shaft to be carried through the roof with provision made for clamping the cables upon the sides at short distances, and with a stairway or elevator in the centre; the cables to run continuously from the street to a terminal room adjacent to and practically a part of the switchboard room. If the operating room is on the lower floor the large shaft through the roof will be unnecessary, provision being made for a shaft or flue large enough to ventilate the conduit, either by natural draft or by a fan.

Now as to the construction of the operating room itself with reference to lighting, heating, ventilating and fireproofing: First, let us consider the contents of the room. The apparatus therein forms a part of every circuit and every conversation passes through it. The time is rapidly approaching when all the circuits will be metallic—that is, a circuit will be no longer a single wire, but two sides which must be balanced within a very small limit—balanced not only in resistance but in capacity and insulation. Then, there are, in spring jacks and keys, contact points numbering in the aggregate into the hundreds of thousands, poor contact in any one of which will cause poor service on some line. The surfaces on which the springs and contacts are mounted, and to a greater or less extent the insulating material of the thousands of miles of wire used in connections, are hygroscopic, and the insulation of this part of the circuit rapidly falls with the increase of moisture in suspension in the air. A particle of dust under a contact spring either opens the line entirely or throws in more resistance than the whole circuit should have. The extension of underground telephone circuits, the increase of electric light and motor lines and the continued demand for better service, all require that better work shall be done in the switchboard room than was even suggested a few years ago. This being the case, more thought must be given in the future to the heating, ventilating and care of such a room than they have received in the past. Instead of letting this matter rest and provision be made for heating as a sort of afterthought after the building is planned, and no provision made for ventilating except by open windows and doors, it must be one of the first to receive attention. The heating and ventilating of the operating room must be planned together. Windows and doors as a means of ventilation must be ignored and windows only used for light. Heating should be by a system of indirect radiation, and the air must be at all seasons of the year of uniform dryness and freed from dust. The coils for heating the air in winter may be used for cooling it in the summer, circulating cold water or a freezing mixture through them instead of steam. The electrical and mechanical engineer must furnish the detailed plans and specifications for this work, and the architect must accept them, together with the switchboard room and cable conduit, as the things around which the building is to be erected.

When windows are used for ventilation good service cannot be expected. In the city where soft coal is burned the soot is a cause of high resistance if deposited on the contacts, and making contacts of platinum will not remove it because the separation of the surfaces is a mechanical one and is not due to surface corrosion. This soot is much worse than street dust since it is adhesive, and the continued closing of contact springs tamps it down on the surface so that only a file or scraper will remove it; on account of its adhesiveness putting contacts vertically will not cure all the trouble for the reason that the particles of soot will not fall off. Smoke from hard coal is less objectionable, but even this causes corrosion of contact surfaces and renders the use of platinum necessary. Apart from these electrical difficulties caused by dust, its presence, more especially gritty street dust in the room, causes the rapid wear of cams, plungers and other parts of the apparatus which require to have a motion which can be affected by friction. A switchboard set so that a draft of smoky or dusty air passes through will arrest a great part of the ponderable particles. The principle of dust arresters used in pipes from sawmills, grinding rooms and the like is that the current of dust-laden air has its direction suddenly changed. The inertia of the particles preventing them from changing their direction promptly, they are left, while the air pursues a tortuous course and escapes. The springs and wires act in just this way on a current of air driven through the board. Enclosing the back of the board is good as far as it goes, but it is not enough. It is much easier to keep dirt out of the room than to keep it out of the board when freely admitted into the room.

In cities exposed to frequent fogs, especially along the coast, the insulation of the apparatus will run very low at times, and the deposition of salt on the surfaces makes them more hygroscopic and tends to increase the escape. The only insulating material suitable for most of the switchboard work is vulcanite or hard rubber. This is a vulcanized compound and a continual moistening and drying of its surface results in the oxidation of sulphur to form sulphuric acid. Both these causes result in a permanent lowering of the insulation. The regulation of the amount of moisture in the air, and its removal above a hurtful limit, has also a direct bearing on the fire-proofing of the board. Of necessity, a great mass of insulated wires must be used to connect key-tables and jacks. The spring-jack connections can to a great extent be cabled and by this means made less inflammable, but the key-boards must be wired with loose wires. There is no insulating material available, so far that it is both moisture-proof and fire-proof. Fire-proof qualities are generally made secondary to water-proof qualities, and so the under and back sides of the boards are covered with an inflammable mass of paraffine, beeswax or rubber-covered wire. If hurtful amounts of moisture can be kept out of the room the problem of fire-proofing is solved, because dry cotton or silk can be used for the insulation of the wires. A wire closely covered with dry cotton is as near fire-proof as it can be made, and the only objection to be brought against its use is its hygroscopic nature and the consequent low insulation resulting from moisture absorbed from the air.

Precautions having thus been taken to prevent the ingress of dust and moisture with the air, the room should also be constructed with reference to its care and with a view to reducing to a minimum the production of dust and dirt within the room. A tile floor, or, at least, one of well-finished hard wood will assist in this, and the janitor must have learned his trade in a picture gallery rather than on a canal boat. Battery and repair rooms must be entirely disconnected from the switchboard and cable rooms, and the operators coming in from muddy streets should not go into the switchboard room to reach their dressing room. Dust collecting and producing carpets, rugs and hangings must be omitted from the furniture, and it may be that sometime the operators will be required to dress in the least dust and lint producing fabrics. Before that time, however, the manufacturers will be expected to produce a cord that will not fray out and add its contribution to the dust.

It may seem that too much importance has been attached to such little things as a regulation of moisture to within a small percentage, and removing dust. But all the precautions advised are no more insignificant than have to be observed in some branches of manufacture, notably the spinning of fine cotton. The telephone service itself is made up of little things. The little things in connection with circuit construction, cable work, strong current protectors and line tests, have been worked out to a greater or less extent, and no step has been so small as not to show an improvement in the result. The next advance is to be in the proper care of the switching apparatus, and in the construction of exchange buildings mainly with a view to the protection of the apparatus.

Now, having decided upon the position of the room in the building, your electrical engineer having laid out the floor plan of board and cable room, your heating engineer having provided ducts and rooms for admitting and treating the air, you are ready for the architect. You will have projected into space the rooms devoted to exchange work, and the connection of these rooms with the street conduits, and the complete heating and ventilating plant attached. This is turned over to the architect. He may not be able with these limitations to introduce all the artistic features he would desire in the front, he may not be able to plan such desirable suites of offices as he would if left to his own devices, he may not be able to plan stores more desirable to tenants than anything else in the neighborhood; but you will have an exchange room which is not an after-thought and which is not the leavings of everything else. In such a room the life of the apparatus will be prolonged, and if originally well constructed it can be depended upon to give uniformly good service.

There may be exchanges working under exceptionally favorable conditions of climate and surroundings where all these precautions would seem unnecessary, but none of them are very expensive and none of them could do any harm. In existing buildings, where the record of troubles shows a preponderance of open contacts and where frequent cleaning of contact points is found necessary, it would undoubtedly pay to introduce the heating and ventilating plan above recommended. An indirect radiation system of heating is fully as cheap as any other, the only

additional expense being the running of the apparatus for ventilation when artificial heat is not required. This expense would not be worth considering if all trouble from open and high resistance contacts could be avoided. That it can be there is no reason to doubt. If the dirt is kept out of the room it cannot get into the board: if moisture is kept out of the room it cannot get into the insulation of the wires. Dirt can be kept out of the room and the degree of moisture regulated just as well in a switchboard room as in a theatre, library or spinning room.

The PRESIDENT: I understand that Mr. F. A. Pickernell has prepared a paper somewhat in the same line, and, before inviting any discussion, I will ask him to read it, so that the two papers may be considered together.

Mr. Pickernell then read his paper, as follows:

SOME GENERAL REMARKS ON TELEPHONE EXCHANGE CONSTRUCTION AND EQUIPMENT.

The modern telephone exchange building should be thoroughly fire-proof. False floors and concealed masses of wires should be avoided, for a fire once started in such places is extinguished with great difficulty. In its erection, everything should be sacrificed that in any way interferes with the particular object for which it is built. In the basement racks are to be provided for underground cables. Between the basement and the terminal room a cable shaft or system of ducts is to be constructed. On the top floor are to be located the operating, terminal, battery and power, cloak and lunch rooms. These rooms should be provided with chemical fire extinguishers, and the manager, fire chief and his assistants thoroughly instructed in their use.

In case of fire every effort should be made to suppress it without calling on the fire department. If the fire should attain considerable proportions, it could at its worst only consume all the combustible matter in the room, for inasmuch as the operating room is on the top floor, the fire could not cripple any of the supporting columns or beams of the building and cause it to fall. If a small fire was started and the average fireman admitted, he would do more damage with his axe and hose than the fire would in entirely consuming the apparatus.

Before a telephone company is in a position to erect a suitable building it is necessary to make definite estimates of the probable extent of the underground work, the ultimate number of subscribers it will be desired to handle at the proposed exchange, the probable number of trunks to other exchanges, the probable number of extra territorial lines, the amount of private wire business, the probable average number of calls per subscriber per day, when the switchboard attains its ultimate capacity. A careful estimate of this kind determines the ultimate capacity of the switchboards, underground cable runs, etc., and consequently fixes the minimum size of the building.

In order that the building may fulfill the requirements of a modern telephone exchange, a technical expert should be provided with these estimates, and his opinion taken before any land is purchased or building erected. He should collaborate with the architect in making the building plans. Mistakes have already been made by telephone companies in adopting plans of good office buildings and afterwards placing the switchboard wherever room could be found. Such buildings have been found unsuitable for modern telephone exchanges. It does not follow from this that the requirements of a good telephone building are necessarily incompatible with the demands of an office building.

One of the first matters to be considered in planning the building is the handling of the underground cables. The system for bringing in the cables should be thoroughly flexible, and permit of the drawing in and out of any particular cable when the point of ultimate equipment is reached. The cables are to be extended through the basement to vertical rows of ducts, or to a suitable cable shaft, extending to the cable terminal room. The massing of the cables in rows of ducts extending to a large number should be avoided. Wherever it is necessary to pass from one system of ducts to another system, the cable should be brought into a vertical row, thus rendering each cable accessible. Before any building plan is adopted, a complete working plan for the handling of the underground cables should be made. This working plan should show the exact location of every cable in the subway at each turn and the location of its inside terminal.

It is preferable to head up cables in a terminal containing a sneak current and lightning arrester. The sneak current arrester should operate with the current of three-tenths of an ampère in 40 seconds, and the lightning arrester should operate when the potential of the wire rises to 300 volts. By using a combined cable head and strong current arrester, economy and space as well as inexpensiveness are insured. The strong current arrester should be so designed that the lines can be tested at this point, by using suitable plugs. The terminal room should also contain a distributing board and chief inspector's desk. The most economical, compact and flexible distributing board that has yet been devised is that known as the "Hibbard iron distributing board." The cable terminals should be connected with the line side of the distributing board by flexible cable, all connections being solid. The switchboard cables terminate on its other side. For cross-connecting wires, Okonite wire No. 20 B. & S. gauge, insulated to $\frac{3}{32}$ of an inch, twisted in pairs, should be used, all connections being solid.

The chief inspector's desk should be located immediately in front of the distributing board and should be provided with a telephone outfit, Morse key and relay. Wheatstone bridge and galvanometer and loops extending to the tower and battery room, local switch-board and chief operator's desk. It should be provided with testing plugs for use at the strong current arrester.

Near the terminal room should be located a power and battery room and in this room battery racks should be provided upon which operators' transmitter batteries and chief inspector's testing batteries can be located. The battery rack should be wired with waterproof wire in a permanent manner. In this room a generator switchboard should be provided, and have terminating upon it loops to the various portions of the multiple board and also the terminals of all generators. Electric motors, water motors, or other suitable power supply, should be located here. Both the terminal room and battery and power room should be so located that it will be possible to enter them without passing through the operating room.

On the same floor and adjacent to the terminal room should be located the operating room. This room should be large and well ventilated, free from elevator shafts, columns or other obstructions. The switchboard should commence at the end of the operating room nearest the terminal room and extend from it in a straight line. If it becomes necessary to deflect the switchboard from a straight line, it should be arranged so that the operators sit on the inside of the curve. This enables the chief operator's desk to be so located that all parts of the switchboard are visible from this point The size of the room necessary will depend upon the ultimate capacity of the switchboard.

If the switchboard is to have an ultimate capacity of 4,000 lines or over the extra territorial trunk section should be the first in the system. It should be equipped with five-point spring jacks and three-point plugs, so that when a line is in use at the trunk section it tests busy at the other boards.

If a switchboard is to have a capacity of less than 4,000 lines, the trunk-board should be made the last section in the system, and the regular Chicago spring jack used. The reason for locating it last in the system is as follows: Whenever a metallic circuit connection is made at any section, an open leg is attached, which extends throughout the rest of the board, to the answering jack, the open leg being shortest on connections made at the last section. In large boards, this introduces an appreciable amount of cross-talk. By making the trunk line section the last section in the board all connections made at this board have a minimum length of open leg, and consequently the switchboard cross-talk is reduced to a minimum. The answering jack should be the last spring jack in the system, thus insuring in every connection at least one of the parties connected having no open leg attached to his circuit. If the answering jack were the first spring jack in the section, every connection would have at least one open leg attached to it extending throughout the whole system.

Next to the trunk section comes the regular multiple board, the number of sections depending upon its present equipment. It has been found that the sections of multiple board six panels wide, of the hog-trough type and having an ultimate capacity of 300 subscribers' drops, is the most desirable form of multiple switchboard. On the back of the hog-trough is to be located tubular clearing-out drops and tubular subscribers' drops. Immediately back of the hog-trough is to be located a cord shelf upon which both cords are to be placed. In the face of the board, immediately above the cord shelf, is to be placed the answering jacks; above the answering jacks, the subscribers' jacks.

The standard condenser listening and long-distance ringing keys with talking contacts of platinum have been found to give most excellent service. On the frame work immediately under and back of the cord shelf is to be located an intermediate distributing board. It has been found that it is possible to so distribute the busy subscribers with those that are not so busy, as to make approximately equal the work for all the operators. In order to do this, without changing the number of the subscriber, the intermediate distributing board has been designed. One side of this board is connected to the answering jack and subscribers' drop, and the other side to the cables coming from the multiple board. By placing two numbers on the subscribers' drop, one on the shutter corresponding with the answering jack and one on the face plate corresponding with the spring jack number in the multiple board, it is possible to make cross connections at the intermediate distributing board and not change the drop number of the subscriber.

A change of this kind will be effected as follows: Suppose that the operator upon which subscriber No. 654 terminates was very busy, and that the operator upon which subscriber No. 235 terminates was not so busy; and also that the subscriber No. 654 was a very busy wire, and subscriber No. 235 was not a busy wire, it would be desirable to interchange the answering jacks of these two subscribers, for by so doing the work of the operators would be more equally divided. This would be done at the intermediate distributing board by cross-connecting the two answering jacks and by changing the face plates on these two subscribers' drops. The office record of circuits should be so constituted as to admit of this dual numbering of drops.

The double track system for intercommunication between offices is recommended. Push buttons connecting local operators with the talking circuits are to be placed within easy reach in front of each operator. All in-coming trunks should terminate on single cords, and be operated by a call wire system. For this purpose the in-coming trunk line operator has his head telephone included in the talking circuit from the other exchanges. The trunk circuits should be arranged so that if the calling wire breaks down, any other trunk line may be quickly substituted, and pending the change, the trunk lines operated by drops. It is also desirable to have the circuits so constructed that when the operator at the originating office disconnects a trunk line, the operator at the receiving office is notified automatically by special signal. This reduces the number of calls on the talking circuit one-half.

In front of the switchboard, in such a position that all sections may be easily seen, a monitor desk should be placed. This desk should have, terminating on spring jacks, loops extending to each operator, to the chief inspector's desk and to circuits in the multiple board. All operating rooms should be carpeted with linoleum to prevent noise by people walking about. On the same floor as the operating room a cloak room and lunch room should be provided. The lunch room should be equipped with tea and coffee urns, lunch table, etc. By providing such conveniences for the operators a better class of women become available and exchange service correspondingly improved.

In closing these remarks I would call attention to the necessity of providing complete working plans and specifications of the proposed equipment, including the cable run, before the construction of the building is commenced. Extensive alterations in buildings and apparatus already made in several of our central offices would not have been necessary had this been done. Such plans are as necessary to the successful and economical erection of a modern telephone exchange as are the plans for the erection of a suspension bridge or other engineering work.

Mr. WILSON: We have had read now two papers, one of which advocates an operating room on the top floor, and the other an operating room on the second floor. I hope that will be freely discussed, because I happen to be in a position where we are about to erect several new buildings, and I would like to have the advantages of these locations fully brought out. It seems to me that the only advantage in having an operating room on the second floor would be in the length of cables, and, as Mr. Patterson has expressed it, the expense of the cables as compared with the value of the second floor would be the only consideration. But, I think the advantages in favor of ventilation and light, and rendering the operating room more exclusive from outsiders, is in favor of the top floor.

Mr. HIBBARD: I think that question is one of the primary points, and just as important in its relation to a telephone exchange as the question of the value of the building. If the operating room is on the top floor you will more than make up for the increased length of cable by having your operating room in a much better place. I think the advantages of having the operating room in the top of a building are very great. It has been the practice generally followed. The ventilation and the light obtained are strong points in favor of the selection of the top floor. It is better to have the operators up there where they are out of the way and more free from interruption. We have exchanges in New York where the operating room has been given a black eye by running an elevator into it. Now, the operating room is for the operators, and, in a large exchange, where you employ from 50 to 100 young women, I think it is a good plan to have them up in the top of the building, out of the thoroughfare. Besides, the operating room should be convenient to where the cable is hung up, and where the distributing board is. That is quite a point to be desired in a big local exchange. These constitute three links in the successful working of an exchange: The head of a cable is one, the distributing board is another, and its entrance to the multiple board is the third. Now, if it is possible to hold those three points within the reach of the man who has it all in charge, it is like driving a four-in-hand team—he has a good grasp on the business. If, however, you put in a terminal point in the basement, and a distributing board away up in a tower, perhaps, and an exchange board in a third place, these links become disjointed, and as a result your team is apt to go badly.

Mr. PICKERNELL: I think one other objection to having the operating room on the second floor is the noise because of the close proximity to the street. In Cortlandt street if the operating room was on the second floor it would be almost impossible to operate it. We have to have three sound-proof booths in the front offices there in order to be able to use the telephone at all.

Mr. CRANDALL: And is not dust arising from the street another objection to placing the operating room on the second floor?

Mr. PICKERNELL: Yes, I think it is.

Mr. PATTERSON: I did not intend to advocate the first or second floor locations as against the top floor in all cases. So far as dust and noise is concerned, the lower floors would not be so objectionable if the operating room was placed in the rear, facing on a court, for instance, and lighted by a skylight from above, and the heating and ventilation taken care of by artificial means.

Mr. HIBBARD: I think that the putting in of dry air into your operating room is of essential importance. We should put in nothing wet, and should keep out all dirt and dust. Now I have noticed in offices located on the top floors where it is impossible to keep the windows open, that they have not only a much pleasanter office to work in, but the operating service is superior. The operators like the fresh air, and the better you treat them in their surroundings the better the operating that takes place. I recollect an exchange in which a few years ago they had flowers at one end of the room, and if you went in there on a hot day the work went on without any appreciable difficulty, and the operators seemed to be a contented lot. I think since that time the flowers have ceased to bloom, and more switchboards have been put in, and it is not the same office either in appearance or in efficiency that it formerly was.

Mr. GIFFORD: I think the locality has something to do with the building of an exchange. In Louisville our exchange or operating room is on the second floor; but we are situated in the middle of a square, in a comparatively clean, pleasant location.

A MEMBER: You combine both recommendations—the second floor and the benefits of the top floor also.

Mr. GIFFORD: Yes, sir. We have a big skylight in the top of our operating room, and then we have windows besides. We have a hard wood floor, and we get very little dust. Our switchboards are all cased in. We don't succeed in keeping all the dust out, however, because we use soft coal there. Now, about bringing in the cables. I formerly had our shifting room up in a little tower on the third floor, but in the last few months I have taken a room about 15 × 20 feet on the first floor, and there we have our underground system coming down on one side, with branches to the east and west, and then on the north side arranged in the same way. We do not lose 25 feet in distance from where our cable terminals come in to where they are switched, and we do away with a great deal of interference and resistance. That room is just like a hall; the windows are bricked up and I have an electric light in there, and nobody gets into that room except one man and my electrician, and I hold them responsible for everything in there.

Mr. CARTY: I think Mr. Pickernell's paper was framed upon the idea that there is more than one employé who could be trusted to go into that room and to do the work there. I think we should so organize our staff that any number could go in there. I think it would be a good thing to have the chief inspector located in that room, because then he is near the point where he could do his testing.

Mr. HIBBARD: I should hardly favor the idea of having a room locked up in which you have your protectors. It is one of the features in a plan of having a testing room that the terminal and distributing room is also a point where you head up your heavy lines of underground cables. As a matter of fact all the testing of wires is done at this head of the cable. It is a point, therefore, of frequent access. That is, you test out all the apparatus, and you test in through the switchboard all the underground cables. One of the points of having it available and next to the operating room is this: The most frequent troubles with the electric light wires are to be expected at night. There has been no arrester put in any exchange which will head off all of these kinds of troubles. Each arrester probably does its work as it has been designed in a particular line, but I do not think we have found any that are good all around. I have had perhaps the misfortune to have my name attached to an arrester, a great many of which are in use. I regret perhaps to be obliged to acknowledge that I know of 10 or 12 experts that would burn up a telephone with an arrester. So that I hardly think we are in a condition yet to wrestle with the question of arresters, because, although it is in a place that no living man would attempt to get into, yet these electric light fellows will creep in over our wires and they are apt to burn sometimes. If our protection is

available in a telephone exchange, we should have there at all hours a means of opening these wires and saving our apparatus. If a current comes in, any chief operator who is posted is able at once to go to the seat of the trouble and remedy it.

Mr. GIFFORD: While I said I was going to put in one man and hold him responsible, I meant to say that I have several very good men working in there to-day, but when I get the thing perfected and finished I shall keep it under the care of just one man, and shall make him responsible for the care of that room.

Mr. PATTERSON: As Mr. Hibbard remarks, I understood him to say that the operating room was not so pleasant if the windows were kept closed. Now, take this room where we are assembled, with four windows on one side and two doors on the other. If the windows are kept open, as those sitting in the rear would no doubt desire, the noise from the street would prevent those in front from hearing what took place in the room. I think this room would be a great deal more pleasant, if, instead of those windows, there were a dozen inlets for fresh air all around the room, and with the temperature graduated to suit the season of the year.

Mr. CARTY: There might perhaps arise a condition where we could be helped out about lighting very much by having the operating room on the top floor and availing ourselves of skylights. If the operating room was on the second floor, you might meet with some conditions that would interfere with the lighting from the windows, and you could not avail yourselves of that expedient.

The PRESIDENT: If there are no further remarks upon these papers, we will proceed to the reading of the next paper, which is by Mr. Carty, on the subject of "Bridging Bells."

The SECRETARY: I believe Mr. Carty has some arrangements to make about his diagram which will occupy him a moment or two, and, while he is doing that, I would like to present the resignation of Mr. C. E. Bailey, as an honorary member, which I received yesterday. It is dated at Atlanta, Georgia, and is addressed to this Association, as follows:

"GENTLEMEN: I respectfully tender to you my resignation as an honorary member of your Association. Success to you. (Signed) C. E. Bailey." I will say in explanation of this that Mr. Bailey was elected an honorary member several years ago when he was in Havana, Cuba. He is now in the United States, in the employ of a corporation which is an active member of this Association, and therefore feels that he should resign his honorary membership.

On motion of Mr. Crandall, duly seconded, the resignation was accepted.

The SECRETARY: I would announce at this time that it is desired that members should not delay in getting their dinner, so that the carriage ride may start promptly at two o'clock to-day, and also the excursion to-morrow; and Mr. Jackson requests me to say that if anybody has been overlooked in receiving their invitations they should make it known to him or to me, and they will be supplied.

The PRESIDENT: Now we will hear from Mr. Carty.

Mr. CARTY: I was asked by the president to prepare a paper to be read before the Association, but owing to the pressure of many matters of business I was unable to do so. I will, however, give you my views briefly on the subject of "Bridging Bells." This is a system of looping, the idea being if you had more than one station on a line to loop the intermediate stations in solid.

(Mr. Carty here illustrated by means of a diagram.)

Later on it was found that a magnet in a line had something in it besides the mere resistance to the copper. The fact that your wire is coiled around on a core offers a resistance to a telephone current a great deal more than that represented by the number of ohms of wire. In nearly all of the lines that are constructed with more than one station looped down, the talking is very poor. A line was built in New York containing eight miles of underground cable and four miles of overhead wire and ten stations looped in solid, and it was impossible to talk over it. The bridging bells were put on that line, and the talking over it now is as near perfect as it could be. It is impossible to tell the difference between a line having ten stations on it, and a line with only two stations. Mr. Sabin, of San Francisco, procured eight of the bells and put them on a line running from San Jose to San Francisco. The line had eight stations looped in, and it had been impossible to use it for through business at all, and talking to the way stations was very poor. But having equipped the line with these bells he reports that it is impossible to tell the difference between talking on the way line and talking on the through line, and says that the induction on the way line bridged in this way is less than it is on the through line. So that actually it has turned out that the line works better with eight stations on it than it did with only two. This line is of iron, and is a grounded circuit, and these bells are simply bridged in or legged on.

Now, if they will give such good results on that line, I do not see why they won't fit in on all of the lines of an ordinary exchange if proper care is taken to look after the resistance of the drops of a central office.

When lines are constructed on the bridge or multiple arc system, the construction of the wire is made much simpler. For instance, a line running to eight stations might be constructed something like this:

(Illustrating on diagram.)

You simply clap on a branch and run off from it like that (indicating). There you see you make an important saving in wire. With the loop plan you would have a station in here (indicating), and use twice as much wire as you would in the bridging plan. A metallic circuit constructed in that way would look something like this (illustrating). You take off from each side of the circuit, you say. Now, supposing you had another station over here (indicating). We tap off from this other branch in that manner (illustrating), and you could carry that still further and go off here (indicating).

To those that have to build lines that simplifies matters very much. To bring that into a way station on the loop plan it would go like this (illustrating), again using twice as much wire.

Now, supposing you have a line connecting the central office with three stations on it. Ordinarily those stations are selected with regard to their location, but on the bridging plan you could have a terminal of a cable here (indicating) and run a leg off here (indicating) to a subscriber, and run another one right from that same conductor up here (indicating), and another subscriber over here (indicating) could be taken off in that way.

The bell is on exhibition in the rear of this hall. It makes a magneto-bell that is much simpler than any yet designed. There is no bottom contact on it, and the bell rings equally well, whether the telephone is on the hook or off.

In looking at some railroad troubles in Albany I found that the drops were down and the business was paralyzed. Mr. Pickernell made a suggestion that I take up some double wound resistance coils and put them in between the drop and the ground. I did so, and that was a perfect remedy, and we ordered 50 of them and fixed it. While there it occurred to me that a bridging bell would act even better. I sent one up and it freed that line from the drop trouble. The particular bell that has been designed for this work has had introduced into it some mechanical improvements that are also applicable to the series bell. We have nut-lock binding posts, and wherever a wire was fastened by a tip these posts were put on and the wire was soldered. The lightning arrester was also taken off, because you might as well paint one on there as to use the present one. The lightning arrester forms a point generally where a fire starts. That bell was prepared with that in view, and if lightning protection is wanted it should be provided by the most approved plan and forming a part of the general scheme of protection against any currents.

I think that is briefly all there is to it. In substance, it is, that if anybody here has a line with a lot of stations on it that is not working well, if he orders some of those bells they will make it work well. The Boston people have used some of the bells and have constructed a fifteen station line for the Armstrong Transfer Company, and they reported to me that, taking the old line at one the working of the new line might be placed at 300. The working of this system in New York has been very gratifying. We started with the New York Central Railroad and reconstructed their ticket line and equipped it with bridging bells. Then the freight people heard about it, and now the result is that we have 40 stations on three lines for that company.

A MEMBER: Are those metallic or grounded?

Mr. CARTY: Those are metallic. This practice is quite different from the ordinary looping practice. For instance, in the American Express Company—who made a big contract with us to equip them in the same way—they moved one of their stations, and we sent one of our men up and he took out the telephone, and, as had been his custom, he twisted the two ends of the wires together. That was a correct thing for him to do, as far as he knew. But it had the result as you see here (illustrating on diagram) of just throwing the whole line out by short circuiting it. Another man, in putting in a bridging station, drove a tack which crossed two wires together, and that prevented its bell from ringing. He started round looking for an opening, whereas he should have looked for a short circuit. So that this practice is diametrically opposed to what he had been used to.

The question of an individual bell should not be confounded with this. The first thing is to get a line over which he can talk. After this is done, then that old saw of individual bells might come up again. You provide signals, and all of the stations are signaled when anybody rings.

The construction of that bell is very little different from some other bells that are made to do the work, but when you come to use 10 or 15 stations on a line you have got to have exactly that construction, and it is such an important matter to the licensees that we are making great efforts to get a patent on it. In designing that we not only have an idea of our immediate wants, but we wanted to get a bell that we could say would work on any line. Take a line with 20 stations. They are building a line now 40 miles long, of copper wire, and to be equipped with 20 stations.

Mr. LOCKWOOD: Is that a metallic circuit?

Mr. CARTY: That is a metallic circuit. But that does not make any difference. If you have a grounded circuit you will have most of the troubles that are incident to grounded disturbances, although Mr. Sabin reports in his case that the disturbance is a little less. That brings up the induction question.

Mr. CRANDALL: Was there any noise which created that disturbance?

Mr. CARTY: What Mr. Sabin had reference to was cross talk from adjoining wires. The magnets in this bell are simply the ordinary ones lengthened out, and 500 ohms wound on each spool. While the resistance of that measured by the Wheatstone bridge is 1,000, Mr. Hamilton makes the measurement of one of those currents about 10,000 ohms to a generator current. Now then, with a higher rate of alternation, the resistance would run away out of sight, and it is safe to say that those bells are practically without any bad effect on transmission.

An experiment which is very interesting in that connection was made by connecting the Boston trunk wire onto this New York Central Railroad ticket line. That made a line extending from the Grand Central depot down town, and there crossing and going over to Brooklyn, and then a branch from that over to Boston, and the observer at Boston could hear the ordering of the tickets at the ticket office in New York just as well, he said, as though they were in Boston. Of course, when we put that line on we added six or eight miles of cable to the Boston line, and that of itself is sufficient to account for a slight diminution of the transmission. But while we had that circuit arranged with 10 stations on in New York and one station in Boston we cut in and out 16 of these bells which we had in the office, and nobody could tell the difference.

Now the point at which this breaks down first is the ringing. If you get more than 20 stations the ringing of the bell would be gradually weakened. If it is desirable to put on more than 20, it is merely a question of design of the generator. In some places we have obviated that trouble by putting in a larger wire. That meant less turns and consequently a lower electromotive force. So we had to put in stronger magnets. It is possible to make a generator that will ring any number of bells. The only limit will be the power of the subscriber to turn the crank. In the New York Central line we put in a push button. I rather favored that. I thought that complicated signals could be sent over a line better by a push button. Our bells are now being made with an automatic cut-in for the generator. With the other bell it is a cut-out.

A MEMBER: Do you make 18 or 20 different signals rather than one?

Mr. CARTY: That is a business arrangement rather than an electrical one.

A MEMBER: There has been no system worked out for that, has there?

Mr. CARTY: I think so. I haven't it in my mind now, but it is not very difficult. You could have a system of short range.

Mr. GIFFORD: It would be very easy to arrange that, just as the District Messenger people do with their calls coming in.

Mr. BAILEY: I want to say with reference to that system, that while the idea of telephone service is supposed to be the supplying of subscribers with an individual or single circuit, that is, a circuit on which but one telephone is placed, yet the conditions are such in a great many parts of the country, and particularly with corporations, that you cannot persuade them that it is the kind of service they want. These corporations are those that have been accustomed to telegraph systems, and they imagine that when they have a system which they can reach individually without the intervention of a central office that they are getting very much better service. It doesn't matter what our opinion is about that, when you try to bring those people to your way of thinking you will find it very much of an uphill job, and the next thing to do is to accept the conditions and accommodate them. That can be done by a system of that kind.

There is another advantage in that system which I think will be available in the future, and that is in the way of giving cheaper telephone service on metallic circuit lines to residences. The chief difficulty that I see about that system is on long extended lines, the liability that you have of damage to the apparatus by lightning. Our company have had for a number of years a system similar to that in operation on quite a number of lines. We have arrived at it by running a shunt wire, commencing at the first station out from the exchange. This shunt wire is passed in through the station, and the calling wire is looped through.

The operation of that is, when a call has been made the removal of the telephone opens the caller's circuit and lets the talking circuit from the earth through the shunt wire, thereby giving a free and independent wire for conversation. The talking over those lines has been magnificent. We get rid of the resistance of the coil through the circuit.

I wanted to ask Mr. Carty if he found any of the effects of those coils reached the earth, as against the talking circuits. In the operation of those lines of ours we have found that in a thunderstorm the usual accidents we had were from lifting the switch and turning out the induction coils or the transmitters. That we obviated by putting a bridge there which shoves the switch to the earth, so that the current more readily passes through this direct wire than through the induction coil. I do not know whether in this system the ringer coils would not be subject to destruction. I think possibly there would be considerable trouble in that respect. However, it may be met by introducing some device. I should say that high resistance coils are more susceptible to damage by lightning, and when you take a line of that kind working in the country, it means stations far away and hard to reach, and therefore expensive, and a long interruption to service.

Mr. GIFFORD: That is a kind of business that it isn't desirable to take.

Mr. BAILEY: But it is a kind of business you are obliged to take.

Mr. GIFFORD: I try to dodge all of that kind of business that I can.

Mr. BAILEY: But I should say in Mr. Wilson's case at Chicago he will find service of that kind that he cannot ignore. You must accept the situation, and devise something that will meet the demand.

Mr. GIFFORD: I do not wish to be considered as throwing any cold water on this system. I hope they will perfect their bridge bell and get a patent on it, but I do not see how it will work in all localities. Perhaps in some localities it will do. I would not know what to do with it—for instance, if I tried to use it for residence service. We make a cheap rate—all our rates are cheap (laughter); we make a cheaper rate to get some residences. You see, in Louisville, the residences are over on one side of the town, and the business portion of the city is on the other, and we debated whether we should cultivate that trade or not. At last we made a cheap residence rate, two and three subscribers on a line. Now, the Louisville woman don't want any other woman listening on her line, and they raised so much of a row that we had to do away with it.

Mr. BAILEY: Then you have had the advantage of educating those people to something better?

Mr. WILSON: Reference has been made to this question in Chicago. At one time we had quite a number of very long private lines and the stations having been added one at a time that condition of things was permitted to go on until we found that we had a good deal of very unsatisfactory private line service. About a year ago we established a rule that we would not take any more private lines with more than five stations upon them, and we have succeeded in getting our private line business on that basis, and where a larger number of stations was required we have put in what we call our branch exchange service. For instance, the West Side Street Railroad Company have a private line of that description. They have their own exchange and their own operators. It costs them more money than it would to have a line run into our exchange at $125 a year each, although we give them a reduction in the rate. The expense of operators to them makes it a little more than they would have to pay us. In that way we have entirely eliminated the long line private wire difficulty.

Now, the only objection that I see to the bridging arrangement on grounded circuits is the difficulty in locating troubles on the lines. We have been bridging our clearing-out office in Chicago for about two years, and find a great improvement. We have some very long underground lines, through cable, which were laid in the early history of the underground business, and with no margin for conversation at all. When we came to inserting the clearing-out drop in the old way it made conversation entirely impossible. After we rewound our clearing-out branches with 300 to 500 ohms it brought the talk right up. So that I am well satisfied that the bridging scheme is the proper thing. But if you can avoid the bridging scheme and have independent lines, it is still better.

Mr. HIBBARD: This bridging-in question is a very important one. In Buffalo we have been doing a good deal of metallic circuit work for the last two years, and we had a good many combination lines, or party lines, which, after the electric lights were in operation, gave very poor service. We commenced this system of bridging in with one or two more subcribers on a line, using first the ordinary bell, which gave us of course very poor service. Then we put in 500-ohm ringing coils. With that system and with 500 ohms in the central office, we are getting first class service with five and six on the line. We have also quite a number of private lines used by railway companies, where they have as many as eight and nine

stations on the line, bridged in with 500-ohm bells, and those stations are giving splendid service.

Mr. BAILEY: Are they all metallic lines?

Mr. HIBBARD: Yes, sir. There is a great saving in wire in doing that work also. We have just legged off on a wire running from Buffalo to Rochester, nearly 90 miles, through a 500-ohm bell, about 35 miles east of Buffalo, and it has given satisfaction. I think with 1,000-ohm bells of the kind Mr. Carty has reference to we will get for that kind of work much better service. Of course, that question of testing comes in, which I think will be a serious one.

Mr. CARTY: Everything has its advantages and its disadvantages, and because one disadvantage is pointed out, it does not by any means settle the whole thing. Take the case of Mr. Sabin, of San Francisco. He had a line 50 miles long. I told him where the trouble was, in the way he had it connected up. He had the advantage, then, of knowing where the trouble was, and the disadvantage of not being able to use the line. Now he can use the line, and there is no doubt but what he can find out where the trouble is.

In New York we do not recognize the long private line difficulty. Where a long private line is not desirable, why, we do not advocate the use of that bell The ticket line that caused the development of this particular bell is the case of New York Central ticket agents scattered all over the city, who, when a traveler comes in to buy a ticket for Omaha, and the condition is that he must get a berth or a seat on the river side of the car, the ticket agent telephones up to the Wagner office and says: "Can I have a lower so and so," and the answer comes back immediately: "Car 5, lower 6." The rapidity with which they transact business over that line is startling, and I can imagine what a time they must have had selling tickets over that line of railroad when it was looped in. Now they have increased the number of their lines, and the American Express Company has come in and the Adams Express Company has been converted to that system. The Adams company has one of these private switchboards and also a number of stations on each of the lines. The lighterage line of the New York Central has a switchboard, but there is a certain amount of their business which they want to do by ringing up direct and not being obliged to go through a switchboard.

We do not want to make any contention for a patent on bridging. The bridging apparatus is not new. It was advocated in a paper read at Minneapolis last year, and one of the first things that Mr. Hibbard did in the long-distance company was to throw out the bridging arrangement and loop the operators in. Down in Cape Cod they had these three-legged lines as long ago as I can remember, and we used to laugh at them, but it turns out that they are the right idea after all. It is a question of the design of the apparatus. We have succeeded in making this a practical thing. You can take any of these wires and quadruplex it, and you would never know who was talking.

In regard to lightning I appreciate Mr. Bailey's position out in the country in having the bells burned out, but I would hate to complicate that bell which has been rendered so simple by putting in any of these devices to get a ground. If there was any other way out of it there might be a bridging designed for that particular use. I think if we tried the most approved arrester he would not have any trouble from burning out. In fact, the trouble he speaks of is not necessarily connected with the bell at all. It is the old question of the transmitter being legged on, and the fact that it is 1,000 ohms does not make it any more delicate than these 500-ohm bell arresters used for bridging. I think lightning jumping across is largely because of the thickness of the insulation; that is a determining factor in making a discharge.

Mr. WILSON: Don't you think it is true that the retardation of the coils increases the tendency to jump?

Mr. CARTY: No, sir; I don't think so.

Mr. HIBBARD: While we are speaking about the lightning's effect, I should think that Mr. Bailey's legging-on of the talking wire was a lightning drop in itself. You get a good deal of chance for the lightning to escape to the ground. When bells burn out by lightning it is due a great deal to the mechanical way in which they have been wound. The winding of a magnet of different design has much to do with it. On a long-distance line, using what is pretty generally known as a tubular drop, when it was first turned out for us, in 500-ohm drops we had a good deal of trouble. We found that the wire burned in the outer wrapper generally. That was changed so that the winding was kept away from the iron. No other change was made, and our drops are not burning out as they did before.

Mr. BAILEY: It is more with reference to the trouble we have experienced with the burning out of the induction coils than the transmitter. We have not suffered with ringer coils of the metallic plates being destroyed, but in our case the ordinary arrangement is to make permanently the telephone satisfactory, the talking apparatus legged permanently on to the iron wire, or to the earth, so that in the operation of the switch there is but one connection made. As against that plan of coupling a telephone with one side of the telephone in contact with the earth, would it not be better to devise switches that will cut loose both sides of the telephone?

Mr. WILSON: I would dislike to see an open contact point put in a switch. It happens once in a while, but so rarely in my experience that I prefer to have the coils burn out rather than the additional contact. I think in curing one evil you would introduce another that would be a worse one.

Mr. HIBBARD: I think it is found pretty generally where you give a high tension current any path at all it will stick to it until it entirely uses it up before it jumps any way. Mr. Bailey has been taking lightning into his loop line and then offering it a chance to get to the ground through the induction coil, and I think it is safe to say it has taken the jump on that account.

Mr. CARTY: In some experiments which we made in the development of strong current protectors, it was found that we could make an air cut-out—which is another name for a lightning arrester—and that it would go out at any number of volts at which you wanted to fix it, and they got it down so low that the actual telephone current would jump itself. Now, it seems to me that if Mr Bailey's exchange were equipped with a lightning arrester of that kind it would remedy the difficulty. At least we should give that a fair trial before we would undertake to complicate a bell.

Mr. E. J. HALL, Sr.: We have had considerable experience in both those, and the 500-ohm bells have been found very satisfactory. I am not an electrician, but I presume the gentlemen will work this problem out. I am speaking now from a business standpoint. I do not see how it would be possible for us to do away with these conductor lines in Buffalo. Some of our underground cables run out two miles, and if we were obliged to make single lines to parties out beyond that we never could do it at a price which they would be willing to pay. But by attaching to a pair of wires at the end of this cable and putting five or six people on, bridged in on that system, we find that we are able to furnish a subscriber a telephone at a reasonable price.

Mr. FARNHAM: I do not know that I can add much to this interesting talk. We have found the bell arrangement to work admirably. We have not tried putting them on grounded lines. My objection has been mainly to the fear of lightning burning the bell coil. Now that we have a lightning arrester, I think we can safely do it, and we have already taken steps to put those bells on some of the lines to see how they will work. I think, as Mr. Wilson suggested, that one of the difficulties in handling them, is the trouble of locating a fault or some disturbance, and I think that is where one of the advantages of electrical measurements would come in. If we have a line with four instruments on it, the resistance of the line will be 250 ohms plus that of the line, which might perhaps be 50 ohms. If the line is open beyond the second station, of course that resistance can be measured and doubled. We have got that 500 ohms, and we know by those measurements where the trouble is.

Mr. CARTY: If the line was open beyond the first station your own bell would ring just the same?

Mr. FARNHAM: I am speaking of the testing of such a line from the main office. In ordinary practice, when a line is open the bell does not ring, and if the line is grounded it rings better: but here, grounding a line, it does not ring the bell at all.

Mr. WILSON: I am speaking of exchange lines, wholly in that regard.

Mr. FARNHAM: We have a metallic circuit from Chicago to Michigan city, about 56 miles. In addition to the two end stations we have three stations bridged across the circuit. When we first put in that equipment we had great difficulty in locating trouble. We overcame these difficulties by simply inserting a little point or switch in the bridge wire. That enabled us to call up the stations and ask them to turn the switch off five or ten minutes, and after they do that we have the old conditions of wires without any complication, and that enables us to locate the trouble, whether it is an open line or a grounded line.

Mr. CARTY: I might say, in regard to the arrangement we have for locating trouble in New York—everything is getting more and more underground there, and the branches of spurs are necessarily made at the central office—we have arranged for a test board on the plan of the long distance board, with private spring jacks to the board. There will be one of these located in each of our central offices, and the wire chief in charge of the private lines will be located in Cortlandt street. If he finds it a short circuit he will take off all branches leading from his room, and he will then throw them on to a drop and dispatch a trouble man on to that branch. If he finds all his own branches are all right, he signals the next office up town, and they have a similar arrangement gone through with until the trouble is located. That can be done in 20 minutes on those complicated lines. We can not only locate the trouble, but get the fault cut off and leave the other part of the circuit working.

Mr. FARNHAM: What I said about measuring lines referred to exchange lines. The private lines in Boston are arranged just as Mr. Carty described.

The PRESIDENT: Gentlemen, there are about ten minutes left before adjournment.

Mr. HIBBARD: I would ask Mr. Wilson to tell us during the time that is left about the ringing in his exchange, using the Edison current. I examined it this morning at the Detroit exchange and I look upon it as an interesting possibility.

Mr. GIFFORD: Before Mr. Wilson tells us about that I have a motion to make. In the interesting discussion this morning we forgot one thing. We listened to two papers and to some very interesting remarks by Mr. Carty. I therefore move that the thanks of the Association be extended to those gentlemen.

The motion was duly seconded and carried.

Mr. WILSON: I will say that we are operating all the transmitters in the main office of the Chicago exchange with the Edison current, and we are accomplishing good results. We use storage batteries. We are using at present five cells of storage batteries, which have an electromotive force of a little over two volts per cell and gives out about five ampères of current. The five cells are connected directly with the Edison current which supplies the office with light, and the storage takes place when we burn the light and we do not observe any diminution in the lighting throughout the building. There is, therefore, no expense for current. The internal resistance of each cell of the storage battery is about two-hundredths of an ohm. Consequently, as you add transmitters, it simply absorbs more current than the storage battery. The object of having five cells is that it enables us to maintain the storage battery throughout the 24 hours without its becoming exhausted. If we connected all the transmitters we would necessarily have to turn on light during the day to recharge them. Our experience has shown that with five cells it works entirely automatically. We supply between 60 and 70 transmitters.

Mr. GIFFORD: How many transmitters will one cell energize during 24 hours?

Mr. WILSON: The arrangement we have contemplates 100 transmitters. We are only operating 60.

Mr. BAILEY: How many transmitters do you couple on to one cell?

Mr. WILSON: At the present time it is about 12, and we adjust the resistance until the current in each transmitter is all that it will stand.

Mr. GIFFORD: What is the size of the battery which you use?

Mr. WILSON: I cannot answer that. I simply authorized the purchase of a storage battery. We use the Edison current for ringing instead of the small generators.

Mr. BAILEY: Do you have any difficulty with the variation of current which the Edison Company furnishes?

Mr. WILSON: No, sir. On one occasion the current was cut off for about ten minutes.

Mr. BAILEY: I have found that the current from all these incandescent plants differs frequently. Where they are supposed to carry 50 volts to 110 they will vary from 90 to 130.

Mr. WILSON: The Edison Company have a very large plant in Chicago, and they supply motors. The Western Union Company use the Edison current for operating their dynamos, and I think the service gives satisfaction.

Mr. GIFFORD: Mr. Forbes uses the same method in the exchange here.

Mr. HIBBARD: In watching the generators in the Detroit exchange this morning, they had three lamps in the open circuit, and you could tell the number of operators ringing at a time by the way the lamps went down and came up, and became bright again. There was an electromotor turning the commutator. There was the old equipment for running the ordinary power generator.

Mr. WILSON: I would say also that 12 transmitters is the maximum, because the more transmitters you connect on a different cell the more current is absorbed from that cell, and you want to adjust the number of transmitters so that the cell will last the 24 hours, or until the lights are turned on again to recharge them. If you are burning lights during the day, with that arrangement it would not be necessary to use so many cells. We found that when we added any more transmitters it would be necessary during the day to turn on some lights to restore the charge drawn from them.

Mr. FARNHAM: Don't you have a battery in reserve in case of accident?

Mr. WILSON: Yes, sir; we propose to have a reserve series of storage cells, and in keeping them stored all the time we will be entirely independent of the source of supply. They will retain the charge indefinitely.

Mr. BAILEY: Why wouldn't it be practicable to supply transmitters directly from incandescent mains without the intervention of storage batteries?

Mr. WILSON: The Edison current itself is not smooth enough, but by storing it in the storage battery little or no Edison current goes around through your transmitters, and then you get out of the storage battery a perfectly smooth current. I will also add that we are now arranging to take out of the American District plant, which is owned by us in Chicago, the battery which is there---and we now have from 10 to 100 cells of gravity battery located in those offices through the city---and we are arranging to substitute a similar arrangement for all those offices.

Mr. BAILEY: The Pennsylvania Railroad Company take battery direct from the main at Pittsburg and Harrisburg, and use the storage batteries at Altoona. They get very satisfactory current for telegraphic purposes without the intervention of batteries.

The PRESIDENT: The hour for adjournment has passed.

The SECRETARY: I wish to say that in accordance with the duty of the secretary he has prepared the usual statistical report, compiled from reports furnished by different companies from the membership of the Association. Of course, it is too long to read, and, as it consists largely of figures, it would not be followed. If there is no objection I will simply report that I have prepared it and will print it in the proceedings as has been customary.

The PRESIDENT: If there is no objection, it may take that course.

Mr. CRANDALL: As a motion to adjourn is now in order, and, while it may seem a little premature, I think we have received such assurances from our hospitable hosts, from the manner in which we have been entertained and are going to be still further entertained, that I desire to offer a vote of thanks both for what we have received and for what we are yet going to receive (laughter and applause).

E. J. HALL, Jr.: I second that motion.

The motion was carried unanimously.

On motion the convention adjourned *sine die*.

THE ATTENDANCE.

The following were in attendance at the sessions of the Convention:

Albree, George, American Bell Telephone Company, Chicago, Ill.
Anderson, A., Miami Telephone Company, Xenia, O.
Baker, C. O., Jr., Newark, N. J.
Barton, E. M., Western Electric Company, Chicago, Ill.
Beck, L. D., Norwich Insulated Wire Company, New York.
Beach, F. G., Central Union Telephone Company, Chicago, Ill.
Bossart, P. W., Detroit Electrical Works, Detroit, Mich.
Brown, J. M., American Bell Telephone Company, Washington, D. C.
Bailey, R. M., Central Tennessee Telephone and Supply Company, Williamsport, Pa.
Barney, C. H., New York.
Childs, W. A., Law Telephone Company, New York.
Carson, D. I., Southern Bell Telegraph and Telephone Company, New York.
Crandall, C. D., Western Electric Company, Chicago, Ill.
Crandall, A. W., Great Southern Telegraph and Telephone Company, New Orleans, La.
Cherry, E. V., Standard Electrical Works, Cincinnati, O.
Cole, W. J., Southern Bell Telegraph and Telephone Company, Atlanta, Ga.
Carney, M. J., Central Union Telephone Company, Toledo, O.
Clark, James, Ohio Valley Telephone Company, Louisville, Ky.
Carty, J. J., Metropolitan Telegraph and Telephone Company, New York.
Clark, J., Jr., Louisville, Ky.
Collins, W. F., *Electrical Engineer*, Chicago, Ill.
Dee, J. R., Michigan Telephone Company, Houghton, Mich.
Dickerson, J. W., *Western Electrician*, Chicago, Ill.
Duroorow, A. C., *Western Electrician*, Chicago, Ill.
Doolittle, C. B., Bridgeport, Conn.
Drake, Flemon, Nebraska Telephone Company, Omaha, Neb.
Doolittle, Thomas B., American Bell Telephone Company, Bridgeport, Conn.
Davis, J. R., Pennsylvania Telephone Company, Harrisburg, Pa.
DeLand, Fred., THE ELECTRICAL WORLD, Chicago, Ill.
Degenhardt, F. E., Standard Underground Cable Company, Chicago, Ill.
Easterbrook, W. N., New York and Pennsylvania Telephone Company, Elmira, N. Y.
Farnham, I. H., New England Telegraph and Telephone Company, Boston, Mass.
Fuller, Arthur G., American Bell Telephone Company.
Forbes, F. A., Michigan Telephone Company, Detroit, Mich.
Gifford, H. N., Ohio Valley Telephone Company, Louisville, Ky.

Greene, W. D., Michigan Telephone Company, Detroit, Mich.
Ghegan, J. J., J. H. Bunnell & Co., New York.
Hovey, F. J., American Telegraph and Telephone Company, New York.
Hall, E. J., Bell Telephone Company, Buffalo, N. Y.
Hall, G. G., American Bell Telephone Company, Cincinnati, O.
Hibbard, A. S., American Telegraph and Telephone Company, New York.
Hovey, W. A., American Bell Telegraph and Telephone Company, Boston, Mass.
Hall, E. J., Jr., American Telegraph and Telephone Company, New York
Hamilton, George A., Western Electric Company, New York.
Ivers, Samuel, Southern Massachusetts Telephone Company, New Bedford, Mass.
Jackson, W. A., Michigan Telephone Company, Detroit, Mich.
Kelly, J. F., Edison Manufacturing Company, New York.
Knight, Frank B., American Bell Telephone Company, Austin, Tex.
Keller, J. N., New England Telegraph and Telephone Company, Boston, Mass.
Land, J. F., Michigan Telephone Company, Detroit, Mich.
Magee, F. A., The E. S. Greeley & Co., New York.
Mosley, C. E., American Telegraph and Telephone Company, Chicago, Ill.
Morgan, A. O., American Bell Telephone Company, Boston, Mass.
McDaniel, C. W., Missouri & Kansas Telephone Company, Kansas City, Mo.
Meaney, E. P., American Telegraph and Telephone Company, New York.
McKinlock, W. H., Central Electric Company, Chicago, Ill.
McFarlane, L. B., Bell Telephone Company of Canada, Montreal.
McQuaide, J. P., National Conduit Manufacturing Company, New York.
Manson, G. T., Okonite Company, New York.
Murray, D. S., Rocky Mountain Bell Telephone Company, Salt Lake City, Utah.
McLeod, J. D., Wisconsin Telephone Company, Milwaukee, Wis.
Marshall, H. P., American Telegraph and Telephone Company, New York.
Morrison, C. A., New York.
McKinstry, J. P, Erie Telegraph and Telephone Company, Cleveland, O.
Mason, F. C., Superintendent Police Telegraph, Brooklyn, N. Y.
Pickernell, F. A., American Telegraph and Telephone Company, New York.
Palmer, H. C., Bell Telephone Company, Buffalo, N. Y.
Price, Charles W., *Electrical Review*, New York.
Powers, E. L., *Electrical Industries*, Chicago, Ill.
Patterson, W. R., Western Electric Company, Chicago, Ill.
Stump, C. E., The Electrical World, New York.
Smith, D. A., Empire State Telegraph and Telephone Company, Auburn, N. Y.
Stanley, H. D., Bridgeport Brass and Copper Company, Bridgeport, Conn.
Stockwell, J. O., Missouri and Kansas Telephone Company, St. Joseph, Mo.
Smith, G. M., Ansonia Brass and Copper Company, Chicago, Ill.
Stockwell, H. D., National Conduit Manufacturing Company, Portland, Me.
Scribner, C. E., Western Electric Company, Chicago, Ill.
Sargent, W. D., The New York & New Jersey Telephone Company, Brooklyn, N. Y.
Storke, H. L., Empire State Telegraph and Telephone Company, New York.
Tyler, M. F., Southern New England Telephone Company, New Haven, Conn.
Uline, A. B., Hudson River Telephone Company, Albany, N. Y.
Wallace, G. Y., Rocky Mountain Bell Telephone Company, Salt Lake City, Utah.
White, A. C., Providence Telephone Company, Providence, R. I.
Wilson, Chas. H., Chicago Telephone Company, Chicago, Ill.
Westbrook, W. T., Delaware & Atlantic Telegraph and Telephone Company, Philadelphia, Pa.
Watson, S. E., Michigan Telephone Company, Detroit, Mich.
Wetmore, J. A., Norwich Insulated Wire Company, New York.
Wyckoff, F. T., Wyckoff Pipe Company, Williamsport, Pa.
Yost, C. E, Nebraska Telephone Company, Omaha, Neb.
Yensen, P., Erie Telegraph and Telephone Company, Cleveland, O.
Zeublin, J. E., Central Union Telephone Company, Columbus, O.

Among the ladies present at the convention were: Mrs. A. O. Morgan, Boston; Mrs. R. M. Bailey, Williamsport, Pa.; Mrs. H. C. Palmer, New York; Mrs. John N. Culbertson, Buffalo, N. Y.; Mrs. W. J. Cole, Atlanta, Ga.; Mrs. A. W. Crandall, New Orleans, La.; Mrs. C. H. Barney, New York; Mrs. H. L. Storke, New York; Mrs. J. P. McKinstry, Cleveland, O.; Mrs. W. N. Easterbrook, Elmira, N. Y.; Mrs. F. G. Beach, Chicago; Mrs. J. E. Zeublin, Columbus, O., and Miss Gifford, Louisville, Ky.

THE BANQUET.

The Telephone and Telegraph Construction Company of Detroit tendered a dinner to the members of the National Telephone Exchange Association and to the ladies and gentlemen attending the meetings, which was enjoyed by over 100 guests, who assembled in the dining room of the Russell House at 8:30 Wednesday evening, the room having been previously decorated with a profusion of flowers, etc. After the usual dishes had been disposed of, Mr. Jackson introduced President Sargent, when the Hibbard Glee Club sang "For he's a jolly good fellow." Mr. Sargent then referred to his high appreciation of the honor conferred in his re-election to the presidency, and then proposed the health of "the entertainers, the Michigan Telephone Company." Mr Thayer responded in a few neatly worded remarks, in which he said:

"I feel it not an easy task fitly to express our feeling of thanks to our entertainers of to-day and to-morrow. It is an easy matter to tender our thanks and to forget how difficult a task our hosts have had to perform, and when memories of the pleasant entertainments afforded in Providence, St. Louis, Minneapolis, St. Paul and other cities arose in their minds they must surely have felt the burden resting on their shoulders. But to-night we no longer remember New York, Providence, St. Louis or St. Paul, for we remember only Detroit, and Detroit will ever live in our memories; while our love for our generous entertainers will increase as time rolls on." Mr. Thayer then referred to the first meeting of the Association at Niagara Falls ten years ago, and paid a glowing tribute of love to the lamented George L. Phillips, the first president of the Association. Mr. Thayer also made several laughable skits at the wire pulling, the exhibitors and other events occurring at that notable first meeting, and closed with the remarks that the telephone exchange is a settled integral part of the business of the community, and adding largely to the prosperity, the comfort and the happiness of the community.

Mr. Sargent then referred to the large number of ladies present and to the fact that they are the only genuine American belle, and called on Mr. Crandall to respond to the toast "The Ladies."

Mr. Crandall made an apt allusion to the beauty of the American belle and to the Southern ladies whom the Association would meet next year.

Mr. Thomas D. Lockwood followed with some witty remarks that caused much laughter, and then General Barney, being called upon, begged to be excused on the ground that he was suffering from a cold so severe in its nature that it affected not only his throat but also his penmanship.

Mr. Storke, Mr. E. J. Hall, Jr., Mr. Zeublin, Mr. Gifford, Mr. Forbes, Mr. Beach and Mr. Lockwood, of Detroit, followed with brief pithy remarks. Mr. Hibbard favored the guests with a solo and the Hibbard Glee Club added to the merriment. At 1 A. M. all joined in singing "Auld Lang Syne" and then retired.

THE BOAT RIDE.

The Michigan Bell Telephone Company invited the delegates and their friends to enjoy a boat ride on the steamer "City of Detroit," and at 2.30 P. M. Thursday, some 75 guests met on board the steamer where they were royally entertained by the company. The ride lasted till after 6 P. M., and enabled the guests to enjoy the views along the Detroit River and Lake St. Clair. Refreshments were served both in the dining room and in "Room 60." One of the pleasantest features of the trip was the sweet melodies sung by Mr. and Mrs. Palmer, Mr. Hibbard and Mr. Knight. An orchestra was also on board, and many of the younger members participated in the dancing. As the boat returned to the wharf three hearty cheers each were given for the Michigan Telephone Company, Mr. Jackson and Mr. Forbes, and all joined in singing "Auld Lang Syne."

CONVENTION NOTES.

The exhibits were few and far between.

Mr. James F. Kelly, of New York, interested many in the Edison-Lalande battery.

The E. S. Greeley & Company, New York, was represented by their widely known Mr. Magee.

Mr. George T. Manson, of the Okonite Company, was on hand, as usual, and added to the name and fame of Okonite.

The Western Electric Company were largely and ably represented and exhibited several of its telephonic manufactures.

The National Conduit Company, of New York was represented by Mr. J. P. McQuaide, and exhibited sections of various conduits.

Mr. Frank Wyckoff looked after the interests of the Wyckoff Pipe Manufacturing Company, of Williamsport, Pa.

Alexander, Barney & Chapin's formation of a new company destroys the prestige of the Ansonia Brass and Copper Company's title to the "A, B and C," or "alphabet" company.

The merits of the Burnley Dry Battery were explained by Mr. J. J. Ghegan, for Messrs. J. H. Bunnell & Co., of New York, in such an able manner that a number of orders were received.

The Norwich Insulated Wire Company, New York, had its president, Mr. L. D. Beck, and Mr. Jean A. Wetmore on the ground with a complete line of spiral wound insulated wires and cables.

The Nubian Iron Enamel Company, Chicago, called attention to the value of their enamel for exposed metal work, and Bonnelite, to be used in place of Chatterton's compound for rendering joints impervious to moisture.

Mr. Gilbert M. Smith, the manager of the Chicago office of the Ansonia Brass and Copper Company, generously distributed some handsome celluloid pocket postage stamp cases among the delegates. Local superintendents of both light and telephone plants should request that one be sent to them by mail.

The Western Electric Company was represented by Mr. G. A. Hamilton, from New York, and by Messrs. E. M. Barton, C. H. Crandall and Mr. Patterson, from Chicago.

Mr. Fred Degenhardt, the western sales agent of the Standard Underground Cable Company, displayed samples of bunched telephone cables with wires twisted in pairs, the special claims for these cables being very low static capacity and high insulation.

A New Compound for Dry Batteries.

A new mixture for filling dry cells prepared by Mr. A. V. Meserole, of this city, consists of the following solid ingredients in the form of powder: charcoal, 3 parts; mineral carbon or graphite, 1 part; peroxide of manganese, 3 parts; lime hydrate, 1 part; white arsenic (oxide), 1 part and a mixture of glucose and dextrine or starch, 1 part; all by weight. These are intimately mixed dry and then worked into a paste of proper consistency with a fluid solution composed of equal parts of a saturated solution of chloride of ammonium and chloride of sodium in water, to which is added one-tenth volume of a solution of bichloride mercury, and an equal volume of hydrochloric acid. The fluid is added gradually and the mass well worked up.

On the Electro-Dynamics of Stationary Bodies.*

BY H. HERTZ.

The collection of principles and formulæ which Maxwell has used for the purpose of exhibiting the theory of electro-magnetic phenomena forms the most complete and most fertile system of all those having the same object in view.

It is much to be desired that a method so essentially correct should be expounded in proper form. The fundamental principles should be stated in a clear and concise manner, the essential deductions should be drawn in the most simple way, and all superfluous notions should be got rid of. Unhappily, Maxwell is far from having attained this perfection in form. He oscillates too often between the reality of facts and the conception of purely hypothetical ideas. Maxwell starts with the notion of forces acting directly at a distance; he seeks the laws according to which the hypothetical polarization of the ether varies under the action of such forces, and he ends by showing that in reality this polarization varies without the forces referred to being the cause of the variations. It is clear that such a method does not satisfy the mind, and leaves a prejudice that the result, and the conclusions drawn therefrom, are not correct.

Moreover, this proceeding introduces into the formulæ many principles which are superfluous, and in some respects incomplete, and which are only significant in connection with the old theory of forces acting directly at a distance.

An example of these faulty physical principles consists in the distinction between the dielectric attractions and repulsions and the electric forces acting, as well as the consideration of the ratio of these quantities. These distinctions would have a meaning if we could draw the ether out of the space it occupies and, at the same time, leave behind the electric forces. According to Maxwell's conceptions, this is perfectly admissible, but it is quite at variance with the ideas gathered from his work.

As an example of incomplete mathematical conceptions I would instance the introduction of the quantity vector-potential into the fundamental equations. In the establishment of our new theory we use potential as a foundation, since by its introduction discontinuous forces acting at a distance are replaced by values determined solely by the state of the medium in the neighborhood of the point considered. But the substitution of forces by quantities obtained by means of the introduction of vector-potential has only one purpose, that of procuring a mathematical advantage; and it is important that the fundamental equations should state relations between physical quantities rather than relations between quantities used merely for calculation.

This imperfection of form which we have just pointed out renders, in many cases, the application of Maxwell's theory excessively laborious. Thus, when I have had occasion to use it, a long time has been necessary to understand the formulæ, and to distinguish their essential signification. The present paper embodies the results obtained in my work of revision and correction.

In 1885 Mr. Oliver Heaviside† worked with the same object in view. The conclusions which he drew from Maxwell's equations are absolutely identical with some of mine, as well as the very simple form which he was induced to give to them. So far, therefore, priority belongs to Mr. Heaviside. In spite of that, I do not consider my work useless. Doubtless the essay is not perfect, but I venture to believe that among all those which have yet appeared mine is that in which most improvement will be found.

I divide the work into two portions. In the first part, A, I expose the fundamental principles and the formulæ following from them. Each formula is discussed, not for the purpose of demonstration, but in order that its meaning and full bearing may be better realized. The groundwork on which I rest is always experience, and the only proof of the formulæ given is experimental. It is clear that each formula cannot be directly demonstrated, but only the entire system of formulæ. The work involves but few equations in addition to those furnished by ordinary rational mechanics.

In the second part, B, I indicate in what way different facts furnished by direct observation can be deduced from the formulæ found, in order to completely establish the correctness of the method.

A.—Fundamental Principles and their Connection.

Electric and Magnetic Force.—The interior of all bodies placed in free ether can undergo electric and magnetic perturbations. We do not know the nature of these variations of state, but only the observable phenomena caused by them. We shall suppose these phenomena known, and by their consideration we shall determine the geometrical relations denoting these variations in state. The electric and magnetic perturbations are connected together; for although they may exist at the same time independently of each other, every change of either affects the other. The existence of each perturbation denotes a store of energy since its change involves a manifestation of energy.

At a given point one can specify the variations of state of each kind with regard to their magnitude, direction, and sense. Consequently, to completely determine either the

*Abstract of original paper, from *The Electrician*, London.
† See *The Electrician* (London), 1885, a series of articles on "Electro-magnetic Induction and its Propagation."

electric or magnetic state, it is necessary to know either a "directed quantity" or else its three components. We shall, first of all, make an important supposition for our theory, namely, that the knowledge of a single-directed quantity is sufficient to fully determine the variation of the corresponding state. Certain phenomena such as permanent magnetism, dispersion, etc., are not included in the supposition; for in these cases the electric and magnetic state at any point is determined by more than one variable. Such phenomena are, however, not included in those we propose to consider.

The directed quantity which serves to represent the electric state we shall call the electric force, and define it by means of the mechanical force exerted on an electrified body placed in free space, and submitted to an electric disturbance. For free space the component of the electric force in any direction is represented by the magnitude of the component in the same direction of the mechanical force. For a point within a body the electric force is defined to be that acting within an empty cylindrical space surrounding the point considered, the cylinder being infinitely thin, and having its axis in the direction of the force.

If we replace everywhere the word "electric" by the word "magnetic," and the electrified body serving for the measurement of electric force by one of the poles of a magnetized needle, we shall obtain the definition of magnetic force.

To fix definitely the sense of direction of the two preceding forces, we shall suppose that the auxiliary electrified body is charged positively, and that the pole of the magnet is the north pole. We shall for the present defer the consideration of the units of the two forces.

We shall denote by X, Y, Z the components of the electric force along the axes x, y, z, respectively, and by L, M, N the corresponding components of the magnetic force.

Energy of the Field.—The accumulation of electric energy which occurs in a given space is a quadratic function of the three components of the force. This is also true of the magnetic energy. It follows that for an isotropic body the energy contained in a unit volume is equal to the square of the resultant force multiplied by a constant. This constant may be different for the electric and magnetic energy. We shall measure energy in Gauss' absolute unit, and choose the unit of force so that in free ether the constant becomes $\frac{1}{4}\pi$.

The energy contained in a unit volume of the disturbed ether is then given by the expression

$$\frac{1}{8\pi}(X^2+Y^2+Z^2)+\frac{1}{8\pi}(L^2+M^2+N^2).$$

The dimensions of the electric force are thus the same as those of magnetic force, and are such that their square has the dimensions of energy per unit volume. For isotropic massive bodies the energy per unit volume is

$$\frac{\varepsilon}{8\pi}(X^2+Y^2+Z^2)+\frac{\mu}{8\pi}(L^2+M^2+N^2).$$

The new constants ε and μ are necessarily abstract positive numbers. We shall call ε the dielectric constant and μ the magnetic constant of the body. Evidently their values enable us to compare the electro-magnetic energy of one body with that of another. The nature of the body does not alone determine the value of these quantities. We can, if we choose, make this value unity for ether, but it is necessary to remark that it is only an arbitrary assumption, and not an experimental fact.

Relations between the Forces in Ether or in Non-conductors.—We shall suppose our axes so chosen that when looking along the axis of x in the positive direction, y will be positive when measured to the left, and z positive when measured upwards. Under these circumstances the electric and magnetic forces are connected by the equations:

$$\left.\begin{aligned} A\mu\frac{dL}{dt} &= \frac{dZ}{dy}-\frac{dY}{dz}\\ A\mu\frac{dM}{dt} &= \frac{dX}{dz}-\frac{dZ}{dx}\\ A\mu\frac{dN}{dt} &= \frac{dY}{dx}-\frac{dX}{dy}\end{aligned}\right\}\ \ldots\ldots\ldots\ldots\ (1)$$

$$\left.\begin{aligned} A\varepsilon\frac{dX}{dt} &= \frac{dM}{dz}-\frac{dN}{dy}\\ A\varepsilon\frac{dY}{dt} &= \frac{dN}{dx}-\frac{dL}{dz}\\ A\varepsilon\frac{dZ}{dt} &= \frac{dL}{dy}-\frac{dM}{dx}\end{aligned}\right\}\ \ldots\ldots\ldots\ldots\ (2)$$

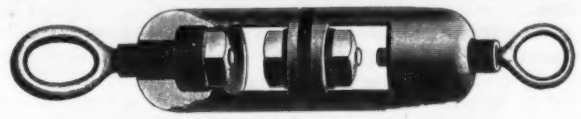
$$\left.\begin{aligned} \frac{dL}{dx}+\frac{dM}{dy}+\frac{dN}{dz} &= 0\\ \frac{dX}{dx}+\frac{dY}{dy}+\frac{dZ}{dz} &= 0\end{aligned}\right\}\ \ldots\ldots\ldots\ldots\ (3)$$

These equations may be obtained either from hypothesis regarding the electric and magnetic constitution of the ether and the nature of the forces acting, or on the basis of known facts. The latter method is much to be preferred, so that the equations can be used to make clear our conceptions of the constitution of the ether.

(To be continued.)

A New Curve Insulator.

The successful and economical operation of electric railways depends largely upon the proper line construction, *i. e.*, on ample strength of all the parts put under strain, and thorough insulation of the trolley wire from the ground. Owing to the weight of the trolley wire, the supports must be very strong, yet they must insulate the trolley line from the supporting wires. This is especially true at curves where the same strain that is often too much for an ordinary iron pole is put on the single centre curve insulator. A new form of insulator for this difficult service is shown in the accompanying cut. It is called the "treble" centre curve insulator and was designed by Mr. Wm. Sharpe, for the Great Western Electric Supply Company, of Chicago. It is made of iron pieces bolted together and insulated from each other by hard rubber washers and bushings. As the cut shows, the three rubber busings are in series, giving a treble insulation. A rubber sleeve, fitting snugly over the body of the insulator keeps this dry, so that the three-fold insulation is obtained in all sorts of weather. The sleeve, by enclosing the insulation, also prevents possible deterioration. The cut does not show this sleeve, but it shows the disposition of the iron and rubber parts which are made unusually strong and appear to be able to withstand the severest practical tests.



CURVE INSULATOR FOR RAILWAYS.

The Chubbuck Break Arm.

In the varied electrical industries, as in other mechanical lines, the old and heavy cast iron appliances are being supplanted by lighter and neater ones of wrought or malleable iron. Quite recently we described a malleable iron wall bracket, made by the Great Western Electric Supply Company. The same firm is now putting out the Chubbuck break arm, which is also made of malleable iron, and is claimed to be stronger, lighter and tougher than the forms now in use. Our illustration shows the rather neat design, with the strengthening rib and taper screw as in the Chubbuck (Springfield) bracket.

The star-shaped section of the arm gives great strength, while the hollow split screws have a slight spring and grip the insulator firmly. Another new feature is the small barbed pin used. As this is made for a five-eighth inch hole, the cross arm is weakened only in a very slight degree. When once driven in, the barbs catch in the wood, holding the arm firmly in its place.

CHUBBUCK BREAK ARM.

Webber's Tests of Belting.

BY CHAS. A. SCHIEREN.

Mr. Webber advocates the use of light weight belting, and upon this theory his test has evidently been made; he claims that for dynamos, and in fact all electric light machinery, single leather and other light weight belts are preferable, and that heavy weight belts are detrimental, etc. However, the belt trade finds the contrary to be the case, from the fact that engineers and electricians favor double belts, and state that they are more reliable in emergencies than single, and for the past three years the demand for heavy double and even three-ply leather belting for use on magneto-electric machinery has very much increased, and only very few single belts are called for, because they are considered a poor investment for that purpose.

Since the introduction of perforating leather belting to exclude the entrained air between belt and pulley, these heavy belts run as smoothly, evenly and noiselessly as the lightest belt on the market. Practical tests with the perforated belts have been made in the most prominent electric light plants of this country, and the result has proved the great benefit of perforating belting for use on dynamos.

Mr. Webber again decries the use of link belts for the same reason he does double belting, namely, weight. It may interest him to learn that careful tests have been made by competent engineers to ascertain whether the great weight of link belts are a loss of power and an injury to the machinery and dynamos, and the result proved that link belts of five times the weight of single leather ran as smoothly with apparently less strain on the bearings than single belts, which can only be accounted for by the fact that link belts are run so much looser than other belting.

In one instance where a main link belt weighing nearly 1,000 pounds was taken off after testing and a double leather belt weighing 300 pounds put on, the result of the test was very much in favor of the link belt. The great weight of the one did not indicate any difference in the power of transmission, and the graceful, easy movement of the link belt made less strain on the bearings of the shaft than the double belt.

Link belts have also been materially improved since the test made by Mr. Webber, in fact they were in their infancy five years ago, and he obtained one of the originals for his test, which have long ago been superseded by other forms made with the American joint and with leather links cut on the plan of two perfect circles, joined in the centre, to assure perfect oscillation. Other link belts of complicated design and construction have been introduced and are now being tested in a practical way before the public and in due time we shall learn the result.

As a rule, very little attention is paid to belting; even the press in describing new electric light plants very seldom mentions the belting, taking for granted that a belt is a belt, no matter how constructed and of what material. With many buyers price is of more importance than quality, and it is surprising how little is generally known about the subject; therefore, such publications as that of Mr. Webber are welcomed and appreciated, because they draw attention to a commodity of vital importance to electric light machinery.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Sept. 15, 1890.

The annual meeting of the stockholders of the Consolidated Electric Light Company of New York will be held on Sept. 17, 1890.

The Tropical American Telephone Company, has returned to its old location at No. 18 Cortlandt Street, in the Telephone Building, where Mr. Frank W. Harrington, the company's popular representative will be glad to see his friends.

Mr. F. Wilson is installing a 1,000-light plant, with the necessary wiring in the Liederkranz Club, to be completed on the 18th of September. The installation work was begun September 6, and Mr. Wilson is under bond for $10,000 to have the work completed at the specified time. Current will be furnished for the lights by the United Electric Light and Power Company, from its Twenty-ninth street station.

The First Underground Street Railway Conduits.—We are informed by the National Conduit Manufacturing Company, of this city, that the contract which it has just closed for underground conduits for the electric street railroad at Buffalo, N. Y., for placing the street railway feeders underground, provides for the first installation of this kind in this country. This will be the first street railway in which the lines carrying current to the overhead trolley wire will be placed underground, and its operation will be watched with interest.

Mr. S. P. Dennison, the inventor and patentee of the autotelegraph machine, is exhibiting it at 50 Broadway, Room 18, this city. Mr. Dennison has made a successful test of these machines between New York and Boston, over the long distance telephone lines, and enough lines were cut into circuit to give a thorough test over a line 1,000 miles in length. The duplicate machine at Boston gave an excellent facsimile of the autograph from the New York machine. Mr Dennison is organizing a company which is expected to put these machines on the market. It is hoped that their purpose will be carried into execution.

The Knickerbocker Electrical Construction Company, incorporated Sept. 1, 1890, has opened an office at 18 Wall street, this city, and proposes to engage in the equipment of buildings with interior electrical conduits for any incandescent electric light system, and will also offer for sale dynamos, motors, fixtures and general electrical supplies. Mr. Franck Z. Maguire, who is well known in electrical and business circles in this city, and who furnishes us with the electrical stock quotations published in our columns each week, is the president of the new company, and Mr. Charles A. Noll, an old and popular electrician, is the general manager. The company is in a position to handle large contracts, and already has under way some large installations of interior conduits.

Correction.—The paragraph in this column in our issue of the 13th inst., stating that the Edison General Electric Company had purchased the entire patent rights of the Diehl motor from Messrs. Diehl & Co., of Elizabeth, N. J., is, we are informed, incorrect. The error was doubtless caused by the fact that the Edison Company is handling exclusively certain of the Diehl devices, and is advertising and selling them through its various offices. The manufacture of the Diehl motor and fans will be continued by Messrs. Diehl & Co. at Elizabeth as heretofore. The excellence of these devices has been so generally recognized by the public as to already demand extensive additions to the firm's manufacturing facilities. These extensions are now being made, and it is stated that the company will in a very short time be in a condition to promptly supply all demands for its goods.

Exhibition Trips.—The River & Rail Electric Light Company, 45 Broadway, this city, is giving daily exhibitions of its storage battery car on the road running from Fort Hamilton to Brooklyn. The road contains some steep grades and very sharp curves, and thoroughly tests the capabilities of the car. This company's system was fully described in a recent number of THE ELECTRICAL WORLD, and a personal inspection of its operation will prove instructive to all who are interested in storage battery traction. The operation of the car in its daily runs has been very successful, the car starting very easily, without jerks, and giving a variety of speeds and running with great smoothness. The tests are almost daily attended by street railway officials and electrical experts, who speak very highly of the operation of the car. This company is said to be having an almost unlimited demand for the Main stor-

age batteries and orders are coming in for fully equipped cars. Sixty cells of this battery have just been installed in a private residence in New York city to furnish current for lighting purposes.

W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, Sept. 13, 1890.

Mr. D. J. Cartwright, of the Cartwright Protector Company is off on a ten days' vacation.

Newburyport, Mass.—The Newburyport Car Company is building eight electric snow plows for the West End Road, Boston.

Mr. S. B. Paine, of the firm of Paine & Francis, has been appointed district agent of the Edison General Electric Company.

Hartford, Conn.—The Hartford Light and Power Company now has 175 arc and 8,000 incandescent lamps in use. This company uses the Westinghouse alternating system.

The Firm of Morss & Whyte, Boston, sole manufacturer of the wire sold by the Simplex Electrical Company as "T. Z. R." and "Caoutchouc" is now offering these wires direct to the trade.

Electric Welding in Canada.—The Thomson International Electric Welding Company has made arrangements with Messrs. Holden & Co., Montreal, for the manufacture of its apparatus in Canada.

Mr. C. H. Buckminster, well known in the electrical supply field in the East, has entered the service of the Eastern Electrical Supply and Construction Company, and will commence active service at once.

The Mather Electric Company, of Manchester, Conn., is building some four pole dynamos to be used especially in connection with 500-volt motors. The company will also build at once some two pole dynamos of a new type for special work.

The Pettingell-Andrews Company has just introduced to the trade a new key and keyless socket for Thomson-Houston lamps, which is claimed can be made cheaper than any socket on the market. Orders have already been received for over 50,000 of them.

Will Enter a Better Life.—The engagement is announced of Mr. S. H. Wardwell, business manager of *Practical Electricity*, and Miss Helen L. Arnold, of Braintree, Mass., daughter of E. Watson Arnold, one of Boston's leading merchants. The date of the wedding has not yet been selected.

The Evans Friction Cone Company has just taken the contract for fitting up the entire plant of the Derby Gas Company, Birmingham, Conn., with its system for driving dynamos. The station will be driven partly by water and partly by steam power and it is the intention to make it a model plant in every respect.

The Perkins Electric Switch Manufacturing Company has been incorporated with a capital stock of $50,000, all paid in. The officers are P. H. Woodward, president; C. G. Perkins, treasurer; J. S. Gibbs, secretary. Offices have been established at 314 Pearl street, and Mr. C. N. Knox, well known to the electrical trade, will at once assume the general managership of the company. With the above management the company will surely push rapidly to the front.

New Thomson-Houston Company.—The Boston *Herald* says that the name of the latest Thomson-Houston company is the Industrial Improvement Company with a capital of $750,000. Oliver Ames is president, and Mr. Alfred A. Glazier, formerly transfer agent of the Atchison company, is treasurer. This company is organized to promote the adoption of electricity as a motive power and for lighting purposes, by the acquirement of horse railways and the conversion of the same into electric railways, etc.

A Big Contract.—The Thomson-Houston Electric Company has just closed a contract with the Davenport (Iowa) & Rock Island Street Railway Company amounting to $350,000. The contract calls for an equipment of 20 miles of single track, five miles of double track, seven 100 h. p. generators, two 350 h. p. Corliss engines, three 300 h. p. boilers and 50 passenger cars, the whole to be completed in 100 days. Another contract with the Tacoma Street Railway Company calls for work amounting to $250,000.

Welding Machines for England.—The Boston *Herald* says that the English electric welding syndicate has just placed an order with the Thomson Electric Welding Company for sixteen welding plants for various classes of work from wire to two-inch shafting. Each plant is to be complete in itself, and ready to be placed with different manufacturers in England, who are waiting for them. The works of the welding company at Lynn are crowded to their utmost with home orders, and it will be at least six months before they can complete this contract. It is the intention of the English company to establish works of its own near London, but until this can be done the American company will assist in every way possible. A contract for the mutual interest and protection of both companies has been executed, which will bring the companies into close relationship in the future. The English company is to be brought out probably in November.

Waterbury, Conn.—The New England Engineering Company has filed articles of incorporation. The purpose for which it is organized is to engage in the business of building, equipping, supplying and operating works or plants for electric lighting and motive power; to build, equip and operate electric railways and stations; to build and equip telephone and telegraph lines and to manufacture electric supplies of all kinds. The company has already commenced to build a four-story brick building 96 × 40 and will occupy two stories of it as soon as ready. It has already secured the contract to build and equip an electric railway six and one-half miles long between Waterbury and Naugatuck, and will commence work on it as soon as the route is approved. The Thomson-Houston system will be used, and the Connecticut Electric Company and Naugatuck Electric Light Company will supply the power. Another contract secured by this company is a three-mile electric railway at Johnson City, Tenn., which will be operated with the Thomson-Houston system. The New England Engineering Company will erect the buildings, which will be 100 × 60, and furnish the complete plant, including Corliss engines and a battery of Campbell-Zell boilers. Mr. A. M. Young is president of this company, A. O. Shepardson treasurer, and E. S. Breed secretary. The capital stock is 40,000 shares of the par value of $100. The success of this company is already assured.

L. H. H.

PHILADELPHIA NOTES.

Branch Office of the Electrical World,
31 City Building, Philadelphia, Sept. 13, 1890.

Media, Pa.—The Williamson Boys' Training School has a 1,200 incandescent light plant just installed by Messrs. Vallee Bros. & Co., of Philadelphia, Pa.

The Quaker City Electric Company has recently installed a 400 light plant in the general office of the Lehigh Valley Railroad Company on Third street below Walnut.

Dissolution.—The firm known as Barr & Kern, dealers in electrical supplies at 612 Arch street, has been dissolved by mutual consent. The business will be conducted by E. K. Barr at the same store.

Vallee Bros. & Co., have installed a 10 h. p. motor for the Market street National Bank, an eight h. p. motor for J. M. Lee 1629 Market street, and two motors for the Delaware River Iron Works to be used on the new gun boats "Bennington" and "Concord."

W. F. H.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Sept. 13, 1890.

Mr. H. H. Pattee, the inventor of the Pattee lamp-hour recorder, which is getting to be widely used, was in Chicago last week.

The Western Electric Construction Company has moved its office from 503 Delaware street to 125 West Sixth street Kansas City, Mo.

The Heisler Electric Light Company, St. Louis, Mo., has recently installed an increase in Heisler apparatus at Belton, Tex., Temple, Tex., Durango, Mex., Monteclova, Mex., and Waxahachie, Tex.

The Whiteside & Fuller Electric Manufacturing Company has been incorporated in Chicago to manufacture electric machinery and appliances. Capital stock, $100,000; incorporators, W. H. Whiteside, W. H. Pettibone and W. D. Carlile.

In the United States Circuit Court, in this city, George H. Seeley and the Western Electric Company, et al, have instituted a suit against the Sperry Electric Light Company, et al, to restrain infringement or improvements in electric lights.

Burt's Electric Light, Fuel and Power Company, of Chicago, Ill., has been incorporated for the manufacture of arc and incandescent dynamos, lamps, motors, etc.; capital stock, $5,000,000; incorporators, Jennie L. Bennett, Allen S. Bennett and Martin C. Burt.

Julius Andrae, Milwaukee, Wis., has secured the contract for a 100-light Mather plant to be installed complete for the Milwaukee Lithographing & Engraving Company, a contract for wiring the Moore Manufacturing & Foundry Company's new works, covering an entire block; and for wiring the Grand Opera House, Milwaukee.

Memphis, Tenn.—Work is progressing favorably on the new power house for the Memphis Electric Light and Power Company, a new company formed by the consolidation of the Brush and the Thomson-Houston companies. The building is being constructed after the plans of the Thomson-Houston Company's station at Salem, Mass.

Mr. A. Irvine, Emelie Building, St. Louis, has met with excellent success in introducing the efficient alternating current apparatus of the National Electric Manufacturing Company, of Eau Claire, Wis. Mr. Irvine has a National dynamo of 1,000 lights capacity on duty at the St. Louis Exposition, that is attracting much attention owing to its handsome appearance and the perfect service afforded.

The St Louis Unicycle Railway Company, whose system was described in the last number of The Electrical World has filed articles of incorporation. The capital stock is $200,000, of 2,000 shares at $100 each. The incorporators are E. M. Turner, Fort Worth, Tex., L. H. Brown, St. Louis, Charles H. Wengler, St. Louis, John H. French, St. Louis, J. W. Tremayne, Charles H. Blake and D. Strowbridge, all St. Louis.

Novel Fixtures.—Several weeks ago we mentioned the novel electroliers, made of deer-heads, which are put out exclusively by the Great Western Electric Supply Company. The large one which was so much admired at this firm's store is now one of the electrical features of the Industrial Exposition at Chicago. Last week the company received a shipment of 19 mounted elk-heads from the Yellowstone National Park. We are informed that most of these have already been sold and will be sent out as soon as they are wired and fitted with lamps.

A Worthy Appointment.—Col. R. C. Clowry, of Chicago, vice-president and general superintendent of the Western Union Telegraph Company, was recently elected to the board of directors of the Columbian Exposition in the interest of the electrical industries. Colonel Clowry has now being elected chairman of the Committee on Mechanical and Electrical Appliances. The directors of the Exposition are to be congratulated on the appointment of one so well fitted to take charge of this important branch of the World's Columbian Exposition.

Chicago is Away in the Lead.—Superintendent Barrett, of the Chicago Fire and Police Alarm Telegraph Department, returned recently from his eastern trip. "I found nothing new in our line," he said, "and I am satisfied that we are away ahead in the police telegraph line of any city in the world. All the cities are interested in the success of our electric lighting system and are anxious to get all the information possible on the subject. I shall get up an explanatory circular letter and send it to all the cities seeking knowledge on this matter."

A Carbon Purchase.—A St. Louis (Mo.) dispatch says: "Webb Hayes, of Cleveland, has purchased a controlling interest in the Fidelity Carbon Company, of St. Louis, for $50,000. The investment has a special significance, as Mr. Hayes is a leading stockholder in the National Carbon Company, of Cleveland, and he is also known to be connected intimately with the Thomson-Houston Company Mr. Hayes has purchased from three stockholders, and will cooperate with General Manager Samuel G. Booker, of the Fidelity. The purchase is part of a scheme to establish a gigantic carbon trust."

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	62@ 64	Wisconsin	117@ 118
Michigan	97@ 99	Bell of Missouri	150@ 155
Great Southern	30@ 32	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co	$130@$132

Mr. Frederick Sargent, late assistant engineer in-chief of the Edison General Electric Company, has located in Chicago as an electrical and mechanical engineer, and has secured a handsome set of offices at 215 Dearborn street, in the Owings Building, where he will make surveys, plans, specifications, estimates and determinations for the application of electricity in all its branches. Mr. Sargent is so well known throughout the country that any reference to his wide experience would seem needless, but it may be mentioned that in 1875 he entered the service of the famous Clyde engineers, Messrs. John Elder & Co., who first introduced the compound and triple expansion engines, and for seven years aided in the designing and construction of compound engines ranging from 500 to 15,000 indicated h. p., and of heavy gearing and mill work. The next four years were spent in the service of American firms designing steam mill and mining machinery, and in the remaining five years Mr. Sargent served as chief engineer of the Western Edison Light Company, superintendent of the Chicago Edison Company, chief engineer of the Edison United Manufacturing Company and assistant engineer-in chief of the Edison General Electric Company. Mr. Sargent does not intend to do construction work, but simply to furnish the necessary data for and to supervise the complete installation of power plants and will be ready to give unbiased advice to parties contemplating such construction.

Detroit, Mich., Sept. 11, 1890.

Mr. Ed. F. Williams, the engine builder of Beloit, Wis., was a visitor in Detroit this week.

Mr. R. T. McDonald, general manager of the Fort Wayne Electric Company, tarried in Detroit for an hour or so this week.

Mr. W. J. Davidson, the special agent of the Thomson-Houston Electric Company, ran down from his home in Port Huron to spend a day in Detroit this week.

Mr. James R. Dee, of Houghton, Mich., has commenced the erection of a new electric light and power station on the Houghton side of the bay. When completed it will be the model station of the West.

Mr. W. H. Wheeler, of Beloit, Wis., was also a visitor here this week. His factory is running overtime in the endeavor to keep up with the demand for clutch pulleys, shafting, etc. In a general conversation Mr. Wheeler referred to the bright outlook for the probable installation of a large number of electric street railway and power plants.

F. Del.

SOUTHERN NOTES.

Norfolk, Va., Sept. 13, 1890.

A Serious Mishap to an Electrician.—Mr. E. W. Dutton, manager of the engineering department of the electric light works at Atlanta, Ga., met with a painful accident one night last week. He had his right arm cut off, between the wrist and elbow. A new exhaust fan had just been put in the main department of the works, and Mr. Dutton was superintending its first trial. He was in the act of feeling the shaft, to see if the journals were hot, when the suction drew his hand along the shaft, and cut it off in an instant. The fan was revolving at the rate of 1,000 revolutions in a minute, and the arm was cut off as cleverly as though done with a surgeon's knife. The blades of the fan were broken out, and the machine badly damaged.

A New Telegraph Repeater.—Richard McIlhenny, an operator in the Postal Telegraph Cable Company's office at Wilmington, N. C., bids fair to win both fame and fortune by an ingenious and superior invention, for which he has taken out letters patent. It is a telegraph repeater, the principal object of which is to simplify the mechanism and circuits of the repeater, so that any operator without special training, can operate it, and also to provide means of preventing "kicks" in the instrument. Mr. McIlhenny's invention also permits of interrupting the sender of the message without rendering the line inoperative. This repeater has been in use for some time at Wilmington at night, on the long Washington and Jacksonville circuit, sending the messages, clear and perfect, to the end of the circuit. The instruments are beautifully made, the workmanship having been executed by a fine electrical instrument maker in Baltimore.

Y. N. B.

ENGLISH NOTES.

(*From our own correspondent.*)

London, Aug. 27, 1890.

Electric Drills.—At Earle's shipbuilding and engineering works, at Hull, great use is being made of electric drills to drill holes 2⅝ inches in diameter through the 2½-inch steel projectile decks of H. M. S. "Endymion" and "St. George." One of these holes can be drilled by an electric drill in 21 minutes, while in the Royal Dockyard at Devonport to drill similar holes in a similar ship it takes two men half a day.

Technical Education.—The commissions for the exhibition of 1851, who have in their hands a large sum of money, which they are permitted to devote to various purposes, have just announced their intention of appropriating the annual sum of £5,000 to the establishment of scholarships to enable the most promising students of provincial colleges of science to complete their studies, either in those colleges or in the larger institutions in the metropolis. The question as to whether this endowment of technical education will tend to turn out more "professors" or highly trained "practical men" is being discussed in the scientific journals. The engineering papers seem to be unanimously of opinion that it will be a case of "mere professors."

The Non-Delivery of Telegrams.—Another electrical subject to which the *Times* has opened its columns for discussion is more within the range of its readers, since it relates to the non-delivery of telegrams owing to insufficient address. The public have grown so accustomed to the immense trouble taken by our post-office to deliver letters, however scantily directed, that they feel somewhat aggrieved that the same attention is not taken in regard to telegrams, the senders of which have, in order to save a few halfpence, so abbreviated the address as to render their intended destination often a matter of pure conjecture. Several instances are certainly given in the correspondence referred to which show that, by the use of a little common sense, supplemented by a local directory, many of the telegrams in question might have been promptly handed in at the correct address. The question is, however, is the deciphering of obscurely addressed telegrams one of the duties of the post office officials?

A New Photometer.—A new photometer based upon the action of light upon iodide of nitrogen, which has recently been brought forward by a M. Lion, has attracted considerable attention. The iodide is prepared by the action of ammonia upon iodine, and is preserved in its "mother liquor." The apparatus consists of two closed metallic vessels, the bottoms of which are of glass. The vessels are connected by a sensitive differential pressure gauge and the light from the standard and from the source which it is desired to compare with it is directed so as to strike the glass cups in a vertical direction. If the two reagents are equally illuminated, they will give off equal volumes of nitrogen, and if not, not. In the former case the manometric columns remain steady; in the latter case the excess of pressure will be indicated by an alteration in their levels, and the light is shifted about until a balance is obtained. If the inventor's statement—that the volume of nitrogen liberated is strictly proportional to the intensity and duration of the illumination—be correct, it would seem as if we had at last within sight a photometer in which we had succeeded in eliminating the personal equation of the human retina.

Electric Traction.—The tests made in February, 1889, by Col. F. K. Hain on an experimental electric line on the Manhattan Ele-

vated Railway, which were several times brought forward in the course of the Parliamentary inquiry on the Central London Railway scheme, have now afforded a text for the *Engineer* for a leading article decrying electric traction, especially when applied to what would be termed railways in England. "It is known that steam locomotives," says the *Engineer*, "comply with all the demands that are put upon them, so far as doing their duty is concerned, It is not possible that an electric motor can give better results in this direction and there is reason to believe that an electric system of propulsion as a whole is much more likely to break down." The article concludes with the following sentence: "The impossible is always that which happens, but it must be understood that there is no reason to suppose that the Metropolitan Railway Company would be justified in substituting electric for ordinary locomotives." By ignoring the deduction of the weight of the rolling stock consequent on the adoption of electric traction, the diminution of vibration, the absence of fumes and the fact that the tests in question were made on a line not exactly an ideal one, the *Engineer* succeeds in proving to its own satisfaction that the day of electric traction is not yet.

The Electric Lighting Franchises Granted by the Board of Trade.—Last week the Board of Trade published a complete list of the electric lighting provisional orders, which have received the royal assent during the past session of Parliament. The total number of "franchises" granted in 1890 is 74, of which no less than 43 refer to local authorities. Last year the Board of Trade only issued 11 provisional orders and two licenses, and but one order was granted to a municipality. It will thus be seen that not only are the orders issued this year far in excess of those issued in 1889, but the proportion granted to local authorities is nearly 60 per cent. of the total as against nine per cent. last year. With the orders granted this year, together with those granted in previous years, some 50 or 60 local authorities must now be in possession of electric lighting powers. Up to the present, however, only one municipality—that of Bradford—has actually got to work, though both Brighton and the vestry of St. Pancras are committed to large schemes. Last year eight provisional orders were granted for metropolitan areas, this year nine more have been granted, and the ground is not yet entirely covered. It is interesting to note the actual result of the memorable electric lighting boom of 1889. By the middle of the year no less than 474 notices of intention to apply for electric lighting powers had been served upon the various local authorities of Great Britain. By the end of the year, although a large number of local authorities had subsequently sent in applications, only 161 were still persevered with, and in the result only 74 orders have been granted.

The New Board of Trade Safety Rules.—These rules, which have been looked for anxiously for several months, have at length been issued. Their contents were known, to a certain extent, since they had been submitted to the leading supply companies, who were asked to comment upon the draft. It is satisfactory to find that many of the stringent regulations have been relaxed and in some cases dropped altogether. The Board of Trade made a great mistake in framing the overhead wire rules which are for the most part incorporated in the new regulations. They specified the insulation of a conductor without having a sample made to see what it looked like and the result was ridiculous. The most noticeable feature in the present regulations is a clause under which an officer of a supply company, if he is "reasonably satisfied" that there is a leak to earth in a house circuit, "may require the consumer to permit him to inspect and test the wires and fittings in the house. We are giving up the good old idea that an Englishman's house is his castle and the tendency of the day is to reduce if not to abolish rights of property and what used to be called liberty. There have been several bold robberies by men who have called at wealthy houses "to look after the electric light," and the intrusion of inspectors on this quest will not be welcome A leak to earth is defined as a connection having a resistance not exceeding 5,000 ohms, and where the power taken by any consumer exceeds 250,000 watts the wires may be divided for the purpose of testing in separate circuits, the insulation of each of which shall exceed 5,000 ohms.

News of the Week.

THE TELEGRAPH.

Dividend.—The Commercial Cable Company has declared a quarterly dividend of one and one-half per cent, payable Oct. 1.

Broken Cable.—The cable of the Great Northwestern Telegraph Company under the Detroit River was broken near Windsor last week by the dragging anchor of some vessel on the Detroit side.

Quarterly Dividend.—The Western Union Telegraph Company has declared a quarterly dividend of 1¼ per cent., payable Oct. 15. The earnings for the quarter ended Sept. 30, partly estimated, are as follows:

	1890.	1889.	Increase.
Net income	$2,000,000	$1,750,000	$250,000
Interest, etc	243,200	210,000	33,200
Balance	$1,756,800	$1,540,000	$216,800
Dividends	1,077,400	1,077,385	15
Surplus	$679,400	$462,615	$216,785
Total surplus Oct. 1	$10,642,383	$9,074,016	$1,568,367

THE TELEPHONE.

A telephone line is being built between East Hardwick and Greensboro, Vt.

Canadian Telephones.—It is said that there are about 25,000 telephones in use in Canada, of which number 20,000 belong to the Bell Telephone Company.

Quarterly Dividend.—The directors of the American Bell Telephone Company have voted to declare a dividend of $3 per share. This was made payable Oct. 15. to stockholders of record Sept. 20. It is the final dividend of the year, making, in the aggregate (including the "extra"), the usual $18 per share.

Good Prospects.—The Boston *Post* says: "Stockholders of the Tropical American Telephone Company can collect a dividend of 10 per cent. per share Oct. 1, to stock of record Sept. 15. Books will close Sept. 15 to 20. There will undoubtedly be dividends also Jan. 1, 1891, and April 1, 1891, as funds are in hand."

Annual Report.—The report of the Bell Telephone Company of Philadelphia, for the year ending June 30, 1890, shows that the cost of the lines was $678,964.10; gross expenses, $242,145.79; gross receipts, $489,425.98; miles of wire on poles, 744; miles of wire on buildings, 1,325; miles of submarine wire, 10¾; total, 2,070¾. The capital stock is $500,000. The dividends for 1886 were 11 per cent., 1887, 12 per cent., 1888, 12 per cent., 1889, 12 per cent.

Conflicting Companies.—A telephone war is reported to be in progress at Peterboro, Can., as a consequence of the organization of a new company, the provisional board of directors of which consists of Messrs. James Kendry, A. Stevenson, C. H. Clementy, F. E. Bell, George Edmison, William Wright, Manager Federal Telephone Company, Montreal, and R. B. Rogers. The new company will supply telephone service at $15 per instrument per year; two instruments, $25.

Cheaper Telephones Demanded.—A hearing was given last week at Washington, D. C., by the sub-committee of the House Committee on appropriations, of which Representative Henderson, of Iowa, is chairman, to Samuel M. Bryan, president of the Chesapeake & Potomac Telephone Company. This corporation is the licensee of the Bell Company, and has a monopoly of the telephone business in the District of Columbia and Maryland. The company is making an earnest opposition to the amendment to the general deficiency bill adopted by the Senate reducing to one-half the rates for telephones used in the government buildings in the District. Mr. Bryan based his argument chiefly on the claim that the heavy royalty paid to the Bell Company and the large outlay for the plant and operating expenses make it impossible for the company to lower the rates and still make a reasonable profit on the investment. It appears that the number of telephones leased by the government in the District is about 275, for which an average rental of $60 is paid.

THE ELECTRIC LIGHT.

St. Boniface, Man.—The woolen factory will put in an electric plant.

Ironton, O.—Messrs. N. S. & A. C. Witman will purchase an electric light plant.

Washington, D. C.—Henry N. Copp will probably purchase an electric light plant.

Alameda, Cal.—The Edison General Electric Company has applied for an electric light franchise.

Glasgow, Va.—The Rockbridge Company is receiving bids for the erection of an electric light plant.

Wellsburg, W. Va.—The Globe Contract Company has a contract to light the city with electricity.

The Gethins Battery, has been adopted by the New England Phonograph Company for all its business.

St. Joseph, Mo.—The St. Joseph Light and Fuel Company has placed a mortgage of $250,000 on its plant.

Tacoma, Va.—It is stated that an electric light plant will be erected by the Tacoma Improvement Company.

Omaha, Neb.—The electric light company will erect a two-story, 50 × 50 brick and stone addition to its plant.

Wheeling, W. Va.—It is stated that the Wheeling Electrical Company has purchased a site for its electric light plant.

The Chaudiere Electric Light and Power Company, of Ottawa, Can., has increased its capital stock to $500,000.

Sandwich, Ill.—Local capitalists are about to organize an electric light company for private and municipal lighting.

Buena Vista, Ga.—The citizens will ask the Legislature to pass an act for an issue of bonds for an electric light plant.

Howell, Mich.—The Howell Electric Light and Power Company has been incorporated with a capital stock of $10,000.

Laurens, S. C.—The New York Construction Company has been awarded the contract for the erection of an electric light plant.

Tacoma, Wash.—The Commercial Electric Light and Power Company has been incorporated with a capital stock of $250,000.

Wetumpka, Ala.—The city has, it is reported, contracted with a Chicago (Ill.) company for the erection of an electric light plant.

Frackville, Pa.—The Frackville & Gilberton Light, Heat and Power Company, has been incorporated with a capital stock of $40,000.

Hawkinsville, Ga.—Efforts are being made to establish an electric light plant. Information can be obtained from Capt. O. A. Horne.

Sanger, Cal.—An electric light plant, to cost about $10,000, will be erected. It is expected to have the plant in operation this month.

Elizabeth City, N. C.—The Albemarle Land Company desires prices on an electric plant with capacity for fifty lights of 30 c. p. each.

Vicksburg, Miss.—It is stated that the Hill City Electric Light Company has purchased site for the erection of its electric light plant.

Fresno, Cal.—The Edison Company is putting in a 1,600 light plant at the Barton opera house. Light will also be furnished for adjacent buildings.

Waynesboro, Va.—R. G. Wright, the mayor, is soliciting estimates on an electric light plant that will furnish thirty arc lights of 1,200 c. p. each.

Middletown, Del.—J. B. Bratton, the new owner of the electric light plant, will install 100 h. p. engine and a 100 h. p. boiler; also two new dynamos.

Bath, Me.—The Bath Electric Light and Power Company has bought out the Gas Light Company, and the two will be operated under one management.

Newport, Ky.—The ordinance granting the Newport Electric Light Company the privilege of lighting the city by electricity has been vetoed by the Mayor.

Doylestown, Pa.—The Doylestown Gas Company has submitted a proposition to the Edison Electric Light Company, of New York, for an electric light plant.

West Toronto, Can.—It is reported that the company which, is about to erect a large corset factory at West Toronto Junction intends to put in an electric lighting plant.

The Royal Electric Company will make application at the next session of the Legislature of the Province of Quebec, to change the par value of its shares from $10 to $100.

Norristown, Pa.—The summer resort known as Oak View Park is to have an arc and incandescent plant. The contract was awarded the Quaker City Electric Company of Philadelphia.

Natural Bridge, Va.—The syndicate which recently purchased the Natural Bridge property is known as the Natural Bridge Park Association, and will, it is said, erect an electric light plant.

Newark, N. J.—The Consolidated Newark and Schuyler Electric Light Companies have awarded contracts for a new central station. The new plant will have a capacity of 30,000 incandescent lights.

Annapolis, N. S.—The Improvement Association has prepared a prospectus, and is asking the citizens to subscribe for stock in a new company which proposes to light the streets by electricty.

Canadian Conduit Company.—The Canadian Interior Conduit Company, Toronto, with a capital of $150,000, will engage extensively in the manufacture of conduits and tubes to contain electric wires.

The Thwing Electric Company has been incorporated at Chicago to manufacture and deal in electric lamps and supplies; capital, $100,000; incorporators, Wilber J. Andrews, Chas. Thwing, Charles E. Piper.

Dover, Pa.—The Dover Electric Light Company will increase its capital stock from $20,000 to $40,000 and increase the capacity of its plant by the addition of a 60 h. p. boiler, a 100 h. p. engine and a 1,350 light dynamo.

Memphis, Tenn.—Additional lights will be wanted by the *Daily Appeal* Publishing Company when it moves into its new building. About 200 incandescent lamps of 16 c. p. each will be required for the new plant.

Port Jervis, N. Y.—The Deer Park Electric Light Company has been awarded the contract for lighting the city for a period of two years, from June 1, 1890. The contract price is at the rate of $105 each for the first 83 lights, and $90 for each additional light.

The Naugatuck (Conn.) Electric Light Company, through A. M. Young, president, has closed contracts for a new brick station, to be built at once, using two 150 h. p. Ball compound condensing engines, Manning boilers, one 500-light dynamo, one 30-light arc and one 1,300-light alternator, all of the Thomson-Houston system.

Vancouver, B. C.—The Street Railroad and Electric Light Company has the new Westinghouse incandescent lighting plant in working order. At present there is one dynamo of 750 lights capacity, which is run by a 100 horse power Westinghouse engine with a 77-inch fly wheel running at a speed of 300 revolutions a minute.

Louisville, Ky.—The Allen-Bradley Company, whose property was extensively damaged by a big fire last spring, started by the explosion of a lamp, has ordered two big electric plants, one for its distillery and warehouse at Louisville, and one to be placed at Frankfort. Several hundred incandescent lamps will be placed throughout the buildings.

Dayton, Ky.—The Citizens Electric Company has been organized with a capital stock of $25,000. The officers are: President, Mayor W. C. McClane; vice-president, John Trapp; secretary, Chas. Bird; treasurer, Anton Beck. The company will submit propositions to the City Council and will erect a plant in the city at once if the necessary permit is obtained.

Windsor Locks, Conn.—The central station plant of alternate current incandescent lighting is being enlarged, and the capacity of the plant will be increased 750 lights, making the total capacity 1,250 lights. The company is operating the Westinghouse alternate system, and the Westinghouse company is now engaged in installing the additional apparatus.

The Portage Electric Company has been organized at Portage la Prairie, Man., with a capital of $20,000. A station will be erected and a plant installed consisting of a 650-light Thomson-Houston alternating current dynamo, run by a 65 h. p. high speed engine. The work, it is estimated, will be finished and the Portage lighted by electricity within two months.

Pocomoke City, Md.—The Pocomoke Electric Light and Power Company has been organized, with a capital stock of $10,000. The officers are: President, Emerson G. Polk; vice-president, Wm. S. Dickinson; secretary and general manager, F. H. Dryden; treasurer, I. H. Merrill; directors, Wm. S. Dickinson, E. S. Polk, R. M. Stevenson, I. H. Merrill and C. H. Colburn.

A Dynamo Seized.—The customs authorities at Winnipeg have seized for undervaluation an electric light plant imported from the United States. A representative of the company has made affidavit that it was through an error that the plant was shipped in on the invoice that accompanied it. The matter has been referred to the Customs Department at Ottawa, Can., for a decision.

Examining Witnesses.—A Canadian exchange says that witnesses are being examined by a commission at Ottawa in connection with the celebrated suit of the Edison Electric Light Company and the United States Electric Light Company, with the view of determining whether the expiration for any cause whatever of a foreign patent obtained after the granting of the Canadian patent, has the effect also of terminating the Canadian patent.

The East End Electric Light Company, of Pittsburgh, delved for many days in the depths of the earth in search of oil or gas. Neither was found, but the company has, as a result of the boring, a plentiful supply of good water. The company will cease to depend upon the city for its water supply, and its well will save it a couple of thousand dollars a year, and thus pay a big interest on the investment required for the digging.

The New Brunswick Electric Light Company has applied for a charter to handle electrical appliances in St. John, N.B., and adjoining districts. Besides the Messrs. Calkin, the applicants are: Silas McDiarmid, Charles H. Dearborn, R. Keltie Jones, W. Watson Allen, George W. Jones, F. Sterling Sharpe, Herbert C. Tilley, Joseph F. Merritt, Daniel E. Berryman, Alfred A. Stockton of St. John, and Wm. J. Morrison, of New York.

Ware, Mass.—It is reported from Boston that the Thomson-Houston Electric Company has instructed its local agent at Ware, Mass., to offer the stockholders in the former Ware electric light plant 25 per cent. as a settlement. The stockholders refuse to accept this, and will demand a showing of the company's books. There is said to be considerable indignation among the 36 stockholders in Ware. The average monthly receipts were about $425.

Catlettsburg, Ky.—The Carpenter Electric Light and Power Company is putting in an electric light plant of 600 incandescent lights of 16 c. p. each. The plant will be running by Oct. 5, and consists of a Continental dynamo driven by a 70 h. p. Buckeye automatic engine Mr. H. Williams is superintending the installation of the plant, and will be the permanent electrician of the company. Mr. D. H. Carpenter is the moving spirit of the organization.

Albina, Ore.—The following bids are reported as having been received for lighting the city with electricity: From the Albina Light and Water Company, for each incandescent lamp of 16-c. p., $2.50 per month; 20-c. p., each, $2.75 per month; arc lights, 2,000-c. p., each, $15 per month; the term of lighting not to be less than five years. From the Edison General Electric Company, Pacific northwest district: Arc lights of 2,000-c. p., each, $14 per month; incandescent lights, 20-c. p., $2 85 per month; 16-c. p., $2.70 per month.

An Edison Factory in Ontario.—The town council of Peterborough, Ont., will submit a vote to the people to raise $11,000 to purchase a site for the works of the Edison General Electric Company, and $4,000 to construct a sewer and drain for the works. This is the carrying out of an agreement between the parties looking to the establishment in Peterborough of extensive works where

the dynamos and other machines and apparatus necessary for the Canadian business will be manufactured.

Bay St. Louis, Miss.—The Gulf Coast Ice and Manufacturing Company has been incorporated with a capital stock of $25,000, with privilege to increase to $250,000, for the purpose of erecting an ice plant, electric light and power plant, etc. Its officers are: President, Paul Conrad; vice-president, A. Aullman; secretary and treasurer, Alex. Lesseps; directors, E. J. Bowers, E. S. Maunsell, August Keller, E. A. Brandao, A. Aullman, Jas. J. Lea, Paul Conrad, Paul Bellocq, John H. Lang and A. Lesseps.

East Portland, Ore.—The East Portland Electric Light and Power Company has offered to furnish electric lights for East Portland as follows: Two hundred incandescent lights of equal power and brilliancy to those now in use for the sum of $600 per month for a period of five years. The company will also furnish additional lights at the rate of $3 per month. In addition to the above, 20 arc lights of 2,000 c. p. each will be supplied for $300 per month, and arc lights above this number are to be furnished at the rate of $15 per month for each light.

The Bristol Electric Light Company, of Bristol, Conn., has accepted the plans of the New England Engineering Company, of Waterbury, Conn., for a new brick building, 68 × 50, with complete steam plant, including one 200 h. p. Harris-Corliss compound condensing engine, one 215 h. p. Hazelton boiler and a line of pulleys and shafting from the Holyoke Machine Company. The electrical fittings will consist of two 30-light Thomson-Houston dynamos, one 400-light Thomson-Houston incandescent and one 50-light Thomson-Houston alternator.

Officers Elected.—The Home Electric Light Company, of Seattle, Wash., has elected the following officers: President, Isaac Dobson; Vice-President and General Manager, Dr. E. C. Kilbourne; Secretary, A. C. Balch; Treasurer, D. T. Denny. The company is the result of a consolidation of the Pacific Lighting and Commercial companies, and its capital stock is $500,000. Two 250 h. p. Armington & Sims engines, four 150 h. p. boilers, 2,600 incandescent lamps, 100 arc lamps, and about 40 miles of wire have been ordered, contracts for the above being signed after the election of the officers.

The Central Electric Light Company, Limited, according to the *Montreal Gazette*, will apply for a charter of incorporation. The object in seeking incorporation is to enable the company to establish in the town of Portage la Prairie and vicinity, a system of electric lighting. The capital stock is to be $25,000, with shares at $50. The applicants are: Robert Watson, Member of Parliament; John Watson, machinist; Alexander McLean, sheriff; David Blythe Hanna, accountant; Hon. Joseph Martin, barrister-at-law; and Smith Curtis, barrister-at-law, all of the town of Portage la Prairie.

Newark, N. J.—The Newark Electric Light and Power Company has been operating the Westinghouse system of alternating current electric lighting for more than a year. In all this time the service of the company has been of such a character as to constantly grow in public favor. As a natural result of this fact the company is now obliged to make extensive additions to its plant. When the plant was first operated 2,250 incandescent lamps seemed to be sufficient to supply all demands. However, the superiority of electric lighting over any other illuminant has since been demonstrated so largely that to-day the plant has to be more than doubled. The contract for 3,000 lights was awarded the Westinghouse Electric and Manufacturing Company a few days ago, and the apparatus is to be installed immediately.

The Connecticut Electric Company's electric light station at Waterbury, Conn., is very elaborate in design and the arrangement of machinery and electrical apparatus place it certainly in the very front rank. The station is 282 × 50 and fire-proof, with a lot 85 × 300, for use in case of necessary addition. The Berlin Iron Bridge Company did the iron work. The Company has fitted it with the following apparatus: Two Corliss engines, one 350 h. p. and one 200 h. p., both compound condensing, and is about to add 300 h. p. more; three Hawkins boilers, one of 125 and two of 100 h. p. respectively; Knowles steam pump and jet condensers and a substantial line of shafting, the work of the Holyoke Machine Company. On the outside the company has an iron smoke stack 100 feet high, five feet in diameter, put up without guys, which is unique and very substantial. The capacity of the station is in arc lights 345, of which 145 are 1,200 c. p. and the others 2,000 c. p.; in incandescents, 3,000 Edison, 1,500 Thomson-Houston alternating. At the present time there are in use 275 arcs and the full capacity, 3,000 incandescents. A visit to this station will well repay any one interested, and it is very creditable to the architectural and engineering abilities of Messrs. Young and Shepardson.

APPLICATIONS OF POWER.

St. John, N. B.—The trolley wires are being placed in position for the new electric railway.

Radford, Va.—The Radford Land & Improvement Company intends constructing an electric railroad.

Reidsville, N. C.—J. H. Barnes desires to correspond with parties relative to the construction of a proposed electric railroad.

The Novelty and Electric Company has secured the advertising privileges on the City and Suburban electric railway of Memphis, Tenn.

Atlanta, Ga.—The Atlanta, West End & McPherson Barracks Railroad Company, which will construct a line 4½ miles long, will operate it by electricity.

Maysville, Ky.—The Maysville Street Railway Company has let the contract to the Edison General Electric Company for the erection of a plant to operate its line by electricity.

Keokuk, Ia.—The Keokuk electric street railway is progressing rapidly, and will soon start two 14 × 42 Hamilton-Corliss engines, driving two dynamos of 8,000 watts capacity each.

Roanoke, Va.—M. M. Rogers, L. L. Powell, W. S. Gooch and others will, it is reported, organize a stock company to erect a plant for the manufacture of the Woolly patent electric motor.

Oakland, Cal.—An ordinance has been passed granting to George W. McNear, J. W. Coleman and William D. English a franchise to operate an electric street railway east and west across the city.

Halifax, N. S.—It is reported that the Halifax street railway has passed into the possession of the Nova Scotia Power Company. It is intended by the present owners to operate the road by electricity next spring.

Los Angeles, Cal.—The Los Angeles & Pacific road, the unused narrow gauge line from Los Angeles to Santa Monica, is to be started up as an electric road. A contract for an electric plant and equipment has been signed.

The Electric Railway Supply and Construction Company, of Chicago, Ill., has been incorporated to manufacture electrical goods; capital stock, $100,000; incorporators, J. M. Berenston, M. A. Berg and others.

Nine Engines Ordered.—The West End Street Railway Company, of Boston, has contracted with E. P. Allis & Co., of Milwaukee, for nine engines of 1,000 h. p. each, to furnish power in operating its electric railway system.

The Pacific Wenstrom Electric Railway Company has been incorporated with Dwight E. Ryland, of San Jose, and C. T. Ryland, Jr., H. T. Scott, John T. Scott, D. I. Mahoney, of San Francisco, as directors. The capital stock is $20,000.

Alexandria, Va.—The Alexandria & Fairfax Passenger Company has organized with Isaac Eichberg, president; M. B. Harlon, secretary, and G W. Fisher, treasurer. The road is to extend to the theological seminary in Fairfax County and to be operated by electricity.

The Gillette Electric Gate Company, of Chicago, Ill., has been incorporated to manufacture and sell electric gates for drawbridges, railroad crossings, etc.; capital stock, $1,000,000; incorporators, Harleigh Gillette, Ernest L. Prussing, Benjamin Stickney, Robert H. Gillette.

Sacramento, Cal.—The Sacramento Railway and Improvement Company has been formed to operate the street railroad system in Sacramento, formerly owned by R. S. Carey, and to operate electric light and power plants. R. S. Carey owns $499,600 of the $500,000 capital stock.

The Widdifield Electric Brake Company, of Toronto (Can.), with a capital stock of $300,000, has applied for incorporation. The applicants are: A.T. Button, W. P. Widdifield, Uxbridge; S. S. Fuller, Stratford; James Lockhart, S. F. McKinnon, Hugh Blain, T. R. Fuller, Toronto.

To be Sold at Auction.—Mention has been made in THE ELECTRICAL WORLD recently of the tribulations of the Squirrel Hill Electric Railway Company, of Pittsburgh, Pa., which is in the hands of a receiver. The receiver has now offered the property for sale at public auction on the 27th day of September.

The Seattle City Railway Company has been incorporated by William A. Underwood and Edward M. Campbell, of New York; Leigh S. J. Hunt, Alpheus F. Haas, George H. Heilbron and Frederick J. Grant, of Seattle. The objects of the corporation are to build, construct and operate street railroads, cable roads, telegraph, telephone and electric light lines. The capital stock is $600,000.

Uniontown, Pa.—A charter has been granted to the Uniontown Street Railway Company with a capital of $50,000 and the following directors: Albert D. Boyd, Geo. A. McCormick, Nathaniel Ewing, John K. Ewing, Jr., and J. M. Freeman. This company has already placed an engineer and corps of assistants at work on the streets, and the work of construction will be pushed as rapidly as possible.

Savannah, Ga.—Ordinances have been introduced in the City Council authorizing the Savannah City Railway Company to construct and operate an electric railroad; the Savannah Street and Rural Resort Railroad Company to extend its line and operate by electricity; the Enterprise Street Railroad Company to construct and operate an electric railroad, and the South Lake & Germantown Railway Company to do the same.

Cumberland, Md., wants rapid transit. A street car company was organized in that town a few days ago, and subscriptions to the capital stock are rapidly pouring in. Electricity will, as a matter of course, be the motive power. Mr. L. A. Fletcher, of Cumberland, is the president of the new company, the secretary and treasurer is Mr. D. G. Landwehr. A street railway in Cumberland should prove a paying institution.

The Lechner electrical mining machine, which is manufactured at Pittsburgh, was put to a severe test at the mines of Capt. Sam Brown, near Boston, on the Youghiogheny River, on the 2d inst., and was pronounced an unqualified success. In five minutes the machine cut through a solid piece of coal 3 feet wide and 4 feet 7 inches deep. Capt. Brown has been greatly interested in this machine, and now intends to use it in all his mines.

Knoxville and Beltzhoover, two bustling boroughs lying on the hills back of Mount Washington, on the south side of Pittsburgh, Pa., are to be blessed by rapid transit. It is the Birmingham Traction Company which is anxious to accommodate the borough dwellers. Two officials of the Birmingham Company drove over the two boroughs the other day and laid their plans. It is said that steps will be taken immediately to push the work of erection.

Dover, N. H.—A new electric railroad has just been started, the people are pleased with it and the managers look forward to a substantial revenue. The overhead system is used. The construction work was done by Mr. A. W. McIsaac, and is said to be a very fine piece of work. The line is seven miles in length, four miles being erected with span wires and three miles with brackets. Mr. McIsaac, the constructor, is well known by electric railroad people in Boston and Brooklyn.

Seattle, Wash.—The plans for completing the belt electric railway through Ballard are now well toward completion. The West Shore and North End Electric Railway will be completed to Ballard within 30 days. It is then proposed to begin work at once on an extension toward Fremont, while the Seattle Electric Railway will build from Fremont toward Ballard to meet it, and a junction will probably be formed about half way between. The two roads will join forces in erecting the car shops near the junction.

Pawtucket, R. I.—A company of Providence and out-of-town capitalists has been formed to construct a trolley road from Providence to Pawtucket, on the west side of Narragansett Bay, and on the east side from there to Barrington, Warren and Bristol. This company has the charter rights from the General Assembly to construct any sort of an electric system, and the sanction of the City Council only remains to be secured. The road will be in competition with the Stonington Railroad on the west side and the Old Colony on the east.

Exciting Street Railway War.—Chancellor Estes, of Memphis, Tenn., was in Chattanooga one day last week and heard the case of the Board of Public Works vs. the Electric Street Railway Company. He issued an order restraining the company from pursuing the work on its Chestnut street line, which had been declared a nuisance. The company had begun the work pending an injunction which had been granted them against the board, preventing the latter from interfering with the rights of the company. This is virtually a victory for the city.

The City and Suburban Electric Railway Company, Memphis, Tenn., has made slow progress with its work during the past two months, owing to the delay by the city in paving two or three of the streets, but now the work is almost completed, and the president, Mr. Holmes Cummins, expects to have the cars running this month. Mr. Jas. S. Kimball, of Boston, has charge of the electrical construction of the road, and is pushing the work on the lines as rapidly as it can be done. Five Thomson-Houston motor cars are ready to go on the track.

Rochester, N. Y.—Work on the electric street railway is progressing rapidly. Fifty miles of track will be laid and 100 new cars will be required. The power plant will consist of four Heine boilers, having a total capacity of 1,600 h. p.; seven Ball triple expansion condensing engines, three being of 300 h. p., three of 120 h. p. and one of 60 h. p. The engines and boilers are being constructed by the Ball Engine Company, of Erie, Pa. It is said that there will be nine Brush dynamos of 120 h. p. each. The power house will be built of sufficient size to accommodate double the amount of machinery mentioned above, which will be introduced as soon as the building is ready.

MISCELLANEOUS NOTES.

The Electric Gas Lighting Company, of Boston, Mass., instituted the suits of which we gave the decision of the court in full in our issue of Sept. 6 against the firm of Fuller, Holtzer & Co. in the United States Circuit Court of Massachusetts. The suit was not brought by Fuller, Holtzer & Co. as was stated in that issue.

The first number of *The Journal of Railroad Car Heating* was issued last week. The object of this new journal is to supply independent information on safe car heating and lighting. Its editor is Mr. Frank Mellersh, and the office of the new journal is at 277 Pearl street, this city. The first number contains some matter dealing with the question of car lighting by electricity. This new journal enters an important field, and one which has not heretofore received the attention which its importance deserves.

Two Fire Alarm Companies Organized.—The Washington Gamewell Auxiliary Fire Alarm Company, capital $50,000, and the Seattle Instantaneous Fire Alarm Company, capital $100,000, the former a State corporation and the latter a local corporation of the city of Seattle, have been incorporated by Fred. J. Grant, R. C. Washburn, C. T. Conover, T. F. Robertson and Maurice McMicken. The objects are to build, operate and transfer the Gamewell fire alarm systems, telephone, telegraph and American district telegraph systems, electric light plants, etc.

Quotations on Electrical Stocks.—Mr. F. Z. Maguire, electrical securities, of 18 Wall street, this city, reports the following quotations of Saturday, Sept. 13, from New York, Boston, and Washington:

NEW YORK.

	Bid.		Bid.
W. U. Tel. Co.	82⅞	Edison Gen. Elec. Co.	99
American Tele. & Cable	83	Edison Gen. Co. Def'd	90
Cent'l & So. Amer.	157	Consol'd Elec. Lt. Co.	....
Mexican	205	Edison Illn'g Co., N. Y.	....
Com. Cable Co.	....	U. S. Elec. Lt. Co.	35
Postal Tel. Cable	39		

BOSTON.

	Bid.		Bid.
Thomson-Houston	50	Ft. Wayne Co.	11½
" Pref'd	25½	Am. Bell	224
" Series C.	12	Erie	48
" " D.	5¾	New England	51
" Int. Co.	....	Mexican	.80
Thomson Welding Co.	.....	Trop. American	.....
Thomson Eu. Welding	80	Edison Phon'gph Doll	1¾

WASHINGTON.

	Bid.		Bid.
Penna. Telephone	25	U S. Electric Lt. (Wash.)	163
Ches & Pot. Telephone	68	Eck. & Sold. Home Elec. Ry.	68
Amer. Graphophone	16	Georget'n & Tennallyt'n.	52

PITTSBURGH.

	bid.
Westinghouse Electric Manufacturing Co.	37¾

PERSONALS.

Mr. T. McCoubray has resigned his position as secretary and general sales agent of the Crocker-Wheeler Motor Company, and has joined the forces of the Okonite Company. His many friends in all parts of the country will no doubt soon have the pleasure of seeing him.

Messrs. Thomas Connelly and Alfred Stevens, two electrical engineers hailing from Manchester, England, were visitors to Pittsburgh, Pa., last week, where they were the guests of Mr. Morris Mead, superintendent of the city bureau of electricity. The gentlemen think American electric lighting magnificent, but are surprised that overhead wires should be so common.

Industrial and Trade Notes.

G. A. Supplee & Co., of 267 North Ninth street, are making additions at their store and increasing their business of house wiring. They disposed of over a thousand batteries last month.

The Connecticut Motor Company, of Plantsville, Conn., will be represented by Mr. F. O. Rusling both at the Edison Company's convention at Minneapolis and at the St. Louis exposition.

The Globe Cordage Works of 102 Arch street, Philadelphia, are adding new machinery to their factory, and before September has passed they will have doubled their present capacity for the manufacture of flexible cords for electrical purposes.

Mr. A. D. Hobbie, 32 Church street, this city, announces himself as the successor to the D. C. Pratt Slate and Crayon Company, and is offering for sale slate for electrical uses, slate cut-outs, switchboards, and other apparatus insulated with the same material.

The Southern Electrical Supply Company, St. Louis, has secured the agency of A. L. Bogart's gas lighting apparatus and of the "Novelty" annunciator, of Philadelphia. This arrangement will enable western buyers to secure these goods promptly at regular rates.

Removal Notice.—The Manhattan Electrical Supply Company, this city, has removed to 36 Cortlandt street, between Church and Greenwich streets. This move is due to the rapid growth of the company's business, which has compelled it to secure better facilities and more commodious quarters.

The Goulds Manufacturing Company has issued a neat special circular and price list of its new triple acting and suction and force pumps, both for high and low-pressure service, which

will be found of interest to all who contemplate the installation of small power pumps in connection with electric motors.

The Safety Insulated Wire and Cable Company, 234 West Twenty-ninth street, this city, has issued a new price list of its electric light, telegraph and telephone wires which it is manufacturing in a great variety of styles. This price list contains also a great deal of valuable information regarding the size, resistance, weight, etc., of the company's wires.

The Pond Engineering Company, St. Louis, has opened additional branch offices in Dallas, Tex., and Seattle, Wash. The growth of this company and the amount of business transacted during the past twelve months is something marvelous, and is a good indication of the decided interest taken in electrical and steam power plants by capitalists.

The Steam Loop.—The firm of Westinghouse, Church, Kerr & Co., of New York City, has issued a circular containing diagrams and descriptive matter concerning the steam loop, as applied to its engines and boilers. From this circular a clear idea can be obtained of the operation and application of the steam loop as used in this company's installations.

The Shultz Belting Company, St. Louis, is meeting with excellent success in the introduction of its woven leather link belt specially designed for high-speed work, as the driving of dynamos, etc. The prominent feature in the belt is its flexibility laterally, due to the coupling pin being made of leather in place of steel, thus allowing the belt to hug a crowned pulley.

The Newman Manufacturing Company, with an office at 623 Chestnut street, Philadelphia, is offering for sale a mechanical or stationary watchman's clock, and has issued a circular describing and illustrating its system, and giving reasons why it is considered to possess advantages over other clocks, and describing the latest improvements which the company has made in its system.

The Fibrantum Company, of which Andres Cassard is the president and Frank A. Doeringer secretary, has an office at 198 Broadway, this city. The company has an insulating material which, it is said, has given excellent results, and which is made into sheet, rod, tube and battery boxes. The company also controls other valuable patented articles, and is seeking capital to increase its manufacturing business.

The W. Ryder Manufacturing Company, Garfield Building, Brooklyn, is sending out a circular which describes its patent shaking roller grate, giving the reasons why it is considered superior to all other rocking or shaking grates, and illustrating its use. It also indicates the way in which these bars increase the boiler capacity 20 per cent., and gives a number of special reasons why these grates should be adopted.

The Fidelity Carbon Manufacturing Company, St. Louis, is having an excellent trade in all its specialties and is turning out a large number of carbon boxes for various battery manufacturers. One form of carbon box recently turned out measured 18 inches × 5 inches × 5 inches, with a half-inch wall, and was a perfect conductor of the electric current. Another box measured 14 inches × 3 inches × 6 inches × ½ inch.

Fans.—The Southern Electrical Supply Company, St. Louis, Mo., has secured the agency of the rotary floor and counter column fans and ceiling fans, and finds a ready market for them as they possess all the merits required of goods of this class and for beauty of design and substantial construction are unexcelled. This company is also carrying all the necessary driving appliances, shafting, etc., required in installing these fans.

The Union Electrical Construction Company, 312 North Eleventh street, St. Louis, has one of the finest assortments of electric and combination chandeliers and fixtures in the West, and makes a specialty of equipping residences throughout with everything required in the electrical line. Superintendents of western stations requiring special fixtures for handsome offices, storerooms or residences should communicate with this company.

The Sunbeam Incandescent Lamp Company, Chicago, has issued a beautiful little eight-page pamphlet descriptive of its incandescent lamps, which "have a guaranteed long life, during which they maintain their rated candle power," and while "requiring only a moderate amount of current produce a light of remarkable beauty." In the manufacture of these lamps "new devices and machinery of original construction are employed that insure a uniformity of production."

The Electro-Dissolvent.—We have received a little circular from the Electro-Dissolvent Company, 368-370 Sixth street, Jersey City, describing the compound which that company is selling for preventing the formation of boiler scale. Quite a number of testimonials are given from those who have used the compound. The pamphlet also contains a set of rules for the management and care of steam boilers, some hints on using the steam engine indicator, and a miscellaneous collection of "points for engineers."

An Electrical Agency.—Messrs. Meserole & Co. have fitted up offices at 26 Church street, this city, and propose to offer their services as agents for any new or established electrical articles that could be exhibited or exploited to advantage. Any small apparatus will be exhibited in operation and its advantages explained to prospective investors. Mr. A. V. Meserole has had a large experience in the electrical business and is well fitted to carry on such a business with considerable advantage both to himself and his clients.

The Electrical Supply Company, 171 Randolph street, Chicago, is noted for the handsome banners and wall cards that adorn its store and that call attention to many of its specialties. A visitor after glancing over a number suggested that by a slight transposition they could be made to represent the excellent business principles of the manager, namely: "Superiority in quality and cheap prices are strangers." "Prompt shipments win profitable friends." "Affability and accommodation open avenues of active trade."

Draughting Instruments for Electrical Engineers.—Electrical draughtsmen will find much of interest in a new catalogue which the Keuffel & Esser Co., 127 Fulton street, New York, has recently issued. Special attention is directed to the very complete and interesting explanations and directions for the use of instruments given throughout the catalogue. This company offers a great variety of draughting instruments for all classes of work and will no doubt be pleased to send its catalogue to all who are interested in its instruments.

Removal.—Owing to the rapid increase in its business and the need of more factory space, the Sterling Emery Wheel Company has decided to move its factory from West Sterling, Mass., to Tiffin, O. The company will there occupy a much larger building, measuring 60 × 200 feet, which is now ready for occupancy. Three railroads will afford ample railroad transportation facilities for the company in its new location. At its new factory natural gas will be used for fuel instead of coal. Although the company moves its factory to the West, the New York store will be continued.

The Telegraphic Time Company, 53 Cedar street, New York, has a large number of its electric clocks in service in this city. They are now used by the New York Clearing House, the Stock Exchange, the Custom House, a number of banks and prominent hotels, and many office buildings. The company was established in 1864. Mr. F. C. Spooner is the secretary and treasurer of the company, and has charge of the New York house. Between 700 and 800 secondary clocks are in use in New York City and Brooklyn besides 100 regulators or master clocks, which control the secondaries. The company offers its subscribers the choice of either the electric regulator or the Pond self-winding clocks.

Change of Firm Name.—The Chloride of Silver Dry Cell Battery Company, of Baltimore City, Md., is the new name of the concern which has heretofore been known as the John A. Barrett Battery Company. The change in name has been made because of annoying confusion in the delivery of mails and telegrams to companies having a somewhat similar name in the same city. This company carries on a large business in medical batteries. Business will be conducted by the same gentlemen who have heretofore had it in charge, who will continue to use the same care to maintain the high standard of superiority which these batteries have always possessed.

The Consolidated Electric Storage Company advertises for agents throughout the United States for the sale of its batteries. This company, as is known to our readers, is engaged in the manufacture of the Julien storage battery, and is the exclusive licensee for the whole of the United States of the Brush storage battery patents. Those desiring an agency should address the company, 120 Broadway, New York. This company has now a large general demand for its battery, but is desirous, by the aid of agencies, of extending its business into every town and city in the country. This will enable dealers in electrical supplies to add the Julien storage battery to their articles of sale, while for live men a good opportunity is offered to sell an article for which the demand is becoming very general.

To Electric Railway Superintendents.—The Electric Merchandise Company, 11 Adams street, Chicago, will send a copy of its new catalogue of railway supplies. It includes everything required in the supply line and has the following preface of interest to street railway men: "We believe that we are in a position, owing to our long and practical experience in the electric railway field, to thoroughly understand the wants and requirements of electric railway companies. We are interested in furnishing the very best and most satisfactory material obtainable, and are, we think, peculiarly fitted to recommend such material. Important improvements have been made by us, as well as careful inspection and tests made of various devices, until we believe we are furnishing the best material for strength, insulation and wearing qualities in the market. Our appliances have the indorsement of roads using all the different systems."

The Standard Underground Cable Company, of Pittsburgh, is not at present using any other than the best Lake Superior copper in its wires and cables, notwithstanding the statement that it was using copper from a Montana mine in which Mr. Geo. Westinghouse, Jr., was interested. This company's orders reached high-water mark in the month of August, the aggregate amount for the month being a little over $123,000, about equally divided between insulated wire and lead-covered cables, the latter being a little the larger of the two. It will be of interest to many who have heretofore made use of this company's No. 6 handbook to know that a new edition will shortly appear, to be known as the No. 11 handbook. It is promised that this will be even more interesting and valuable to electrical people than former editions. It will be printed on specially prepared paper, in convenient pocket form, containing 175 pages.

The Accumulator Company, 44 Broadway, this city, has issued a circular setting forth the advantages of the accumulator system for street cars. Sixteen reasons are given why the Edco car, using the Accumulator Company's storage batteries, is considered superior to other systems. Another circular which this company has issued contains testimonials as to the usefulness and economy of accumulators in connection with electric light plants. These testimonials are very complimentary to the company's system and are furnished by users of its batteries in all parts of the country. Some of the testimonials are from well known electrical engineers such as Lieut. Bradley A. Fiske, F. Jarvis Patten and others. Testimonials are furnished by the New York Ponograph Company and the Kentucky Phonograph Company as to the merits of these accumulators, as used in the operation of the phonograph.

The Shaver Corporation, Broadway and Fulton streets, this city, is said to be four months behind its orders for telephones. Some of their recent installments were for the Jackson Iron Works New York, where there are 36 stations, 12 in the main office, 12 in the supply office and 12 connecting the different foremen. The 12 instruments in the main office can be connected to any one of the superintendents or foremen, without interference. By the use of Mr. G. F. Shaver's new four-point compound push button any one of the 36 instruments can be rung up. The instruments in the main office are arranged on the "Bank" system, being all connected on one sounding board. Eleven stations are being installed in a large cordage factory in this city where it is necessary to use a ten inch gong to call the operator ten feet away, the noise being so great. The company also has in operation five sub-companies in New Hampshire. In Buffalo, N. Y., the company has an exchange using ten instruments, and a similar one is in operation in Chicago.

At the St. Louis Exposition.—One of the most striking exhibits, as indicating the great advance of home manufacture, is that displayed by Queen & Co., of Philadelphia. This enterprising firm show a full line of their standard electrical test instruments. First should be mentioned the collection of resistance boxes, which is probably the finest assortment of American make ever placed on exhibit. The "Queen's" standard resistance boxes, No. 1 standard megohm box, P. O. Box No. 2, and a full line of their new portable testing sets make a showing that will interest every electrician. These testing sets appear to possess valuable peculiarities, and it is said by the company that there is a great demand for them. Ammeters and voltmeters for all classes of work are attractively shown. Well-known types are to be seen, such as the "Ayrton and Perry," "Deprez-Carpentier," "Cardew" electro-dynamometers, and also Queen's new "magnetic vane" meters, which, while but recently placed on the market, are finding an extended use. They are adapted for central stations, electric railways, marine plants, isolated plants, etc. Reading telescopes, galvanometers, speed indicators, testing batteries and other instruments, together with those mentioned above, go to make up an exhibit that reflects great credit upon Queen & Co.

The Ball Engine Company reports that its shop is crowded with orders, having, at the present time orders for 10,000 horse power, largely compounds. Among the orders are the following: Rochester Street Railway Company, Rochester, N. Y., three 300-h. p. triple expansion; three 150-h. p. standard, and one 60-h. p. standard; Buffalo Street Railway Company, Buffalo, N. Y., six 300-h. p. double compound; Southern Railway Company, St. Louis, Mo., five 150-h. p. tandem compound; Edison Electric Illuminating Company, Brooklyn, N. Y., three 250-h. p. double compound; Newark Electric Light and Power Company, Newark, N. J., two 250-h. p. double compound; Central Passenger Railway Company, Louisville, Ky., three 150-h. p. standard; Walla Walla Gas and Electric Light Company, Walla Walla, Wash., one 100-h. p. compound; American Waltham Watch Company, Waltham, Mass., one 300-h. p. double compound; Naugatuck Electric Light Company, Naugatuck, Conn., two 100-h. p. compound; Schuylkill Electric Railway Company, Pottsville, Pa., one 150-h. p. standard; Columbia Electric Light Company, Philadelphia, Pa., two 100-h. p. tandem compound; Essex Street Railway Company, Salem, Mass., one 100-h. p. standard, and one 100-h. p. tandem compound; Amsterdam Street Railway Company, Amsterdam, N. Y., one 125-h. p. standard; Northwest Electric Supply & Construction Company, Seattle, Wash., four 35-h. p. standard, and one 150-h. p. tandem; City Gas Light Company, Norfolk, Va., one 125-h. p. standard.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Hard Rubber.—1. I enclose a clipping, giving some account of the alleged discovery of electricity direct from heat, by Mr. Cox. Is there any truth in it? 2. Can I get hard rubber cast to shape? for example, I want a lot of pieces ¼ × 3-16 × 6 inches long, with a slot one-thirty-seconds of an inch wide, and one-sixteenth of an inch deep running through its length. R. C.

1. The clipping you send is probably a gross exaggeration. One of Mr. Cox's propositions is simply a modification of the old thermopile, which has not proved itself any efficient means of obtaining electricity. Whether there is any other invention than this behind the report, we are unable to state, for Mr. Cox has as yet made very little of his plans public. 2. Hard rubber can be formed into odd shapes, like that you require; also can any of its patented substitutes, of which there are several now in the market.

Concerning Resistances.—1. Will you please give me a simple rule for calculating size of wires for incandescent lighting? For example, we have 40 lamps of 110 volts and six-tenths ampères, 500 feet away from the dynamo; allowing five per cent. loss, what size wire should be used? 2. In speaking of the resistance of a motor as being so many ohms, is the resistance of the motor supposed to be hot from running, or cold? 3. How many times greater is the resistance of German silver wire than that of copper? F. B. W.

1. Ohm's law will give you the permissible resistances, and you can then, knowing the distance, take the necessary sized wire from any wire tables. We would advise you, however, if you have much such computation to do, to get one of the small wiring hand-books, where the results are tabulated in admirably convenient form. Badt's "Hand-Book of Incandescent Wiring" would prove satisfactory. 2. In speaking of motor resistance, it should always be stated whether resistance hot or resistance cold is meant. If nothing definite is said, we should presume that resistance meant resistance at the ordinary temperature of the air—that is, cold—rather than that running. 3. The specific resistance of German silver varies quite widely, according to the composition. The usual resistance is about 12 times that of copper.

Photometers.—It has occurred to me in reading of photometric experiments that there are excellent possibilities of measuring light by a method based on the varying resistance of selenium. Would it not be possible to arrange a standard battery and galvanometer in circuit with a selenium resistance so that the light from a lamp of known candle power should fall on the selenium and produce a definite deflection? By then substituting the light to be measured for the known light, its relative intensity could be easily measured. Has this ever been done, and is there any practical difficulty in it? N. H. S.

Photometry, by the method you suggest, has been tried, but there are certain practical difficulties that stand in the way of its success. The performance of selenium is not altogether uniform, unluckily and the difficulties of manipulation of the apparatus are consequently great. It is hard to arrange the selenium photometer for a bridge method because of a difficulty of getting the selenium resistances to behave alike. Another objection is that the rays producing effect on the selenium are not altogether those which produce visible illumination, so that in comparing lights of different qualities one could not be certain of a fair comparison. The apparatus as tried has given fairly good experimental results; but it does not compare in simplicity and general usefulness with the Bunsen photometer.

Designing Armatures.—I met with one point in Hering's Dynamo Electric Machinery that I cannot quite determine—the assuming of one and three-tenths volts per foot of wire on the armature. Just what is meant by it? 2. To construct an armature for high potential, is it necessary to have as many wires on the armature as possible? 3. If a 2,000 c. p. arc lamp requires 50 volts, what amount of current should it consume, and should the current remain constant when a large number of lamps are running in series A. H.

1. The one and three-tenths volts per foot refers to what is called active wire, that is to say, wire lying between the pole pieces and the core of the armature. The length of wire on which the voltage reckoned should be all active wire, that is to say, should be directly in the path of the lines of force from the pole pieces through the armature. 2. For a high potential armature it is obviously necessary to have as many feet of active wire as the required potential demands. As the current required in high potential machines is usually not large, the armature is generally wound with a very considerable number of turns of comparatively small wire. 3. The so-called 2,000 c. p. arc lamp of 50 volts requires 10 ampères of current, whether it is run singly, or in series with an indefinite number of other lamps. You see that as 10 ampères is quite sufficient to operate an arc lamp, in designing an arc machine, the wire on the armature does not have to be very large.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

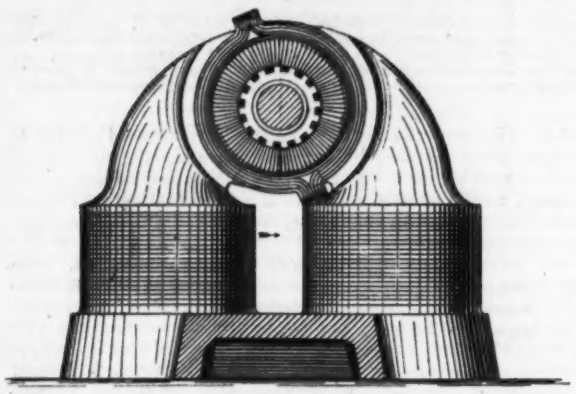
Three Links.—Travelers on business or bent on pleasure in variably visit one of the great cities of the West, if their journey is at all prolonged. Nowhere else can be seen such centres of enterprise and American vim as in Chicago or Kansas City, and few invite lovers of elegance and beauty like St. Louis. In going farther into the "Great West," there are various routes the tourist may select from, but supposing the start is made from Chicago, the great starting point of western travel, no line can be found more desirable than the Chicago and Alton, the great "Three Link" route, and its unsurpassed connections. Elegant cars, courteous train men, a first-class track, and every convenience that modern railroading employs is here found for safety and comfort. The country traversed is unexcelled for beauty of scenery—the veritable garden of the continent. Be sure and secure tickets of the Chicago & Alton if you would have a pleasant journey.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED SEPT. 9, 1890.

435,931. Lamp Holder and Switch; Charles H. Herrick, of Winchester, Mass. Application filed May 16th, 1890. In this lamp holder the spindle is mounted in two supports, which may serve as electrodes of the lamp, held rigidly between two discs or heads of insulating material, one of the journals of the spindle being insulated, the springs which co-operate with the spindle to make and break the circuit and hold the spindle in a given position being supported at both ends by the discs.

435,958. Method of Regulating Electrically Operated Mechanism; Merle J. Wightman, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Appli-



435,982.—REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

cation filed Sept. 9, 1889. The invention consists in a method of obtaining by suitably arranged connections different degrees of speed when two motors are geared to a single machine; first, by placing the two motors in series; second, by regulating the counter-electromotive force of one or both of the motors by suitable changes in the field magnet strength so as to produce a higher rate of speed; third, short-circuiting one motor after its counter-electromotive force has been reduced to a point where short-circuiting may be safely accomplished; fourth, connecting the two motors in multiple arc, and fifth, by regulating the field magnet strength of one or both motors to obtain the highest rate of speed.

435,964. Electrical Amusement Reporting Apparatus; Melvin D. Compton, Newark, N. J. Application filed June 10, 1890. The invention covers a system for reporting ball games or other sporting events by means of an exhibition board having openings, behind which are rotating numbered discs geared to electric motors, each motor having two circuits so arranged that the motor may be made to make a part of a rotation only on the completion of one of the circuits.

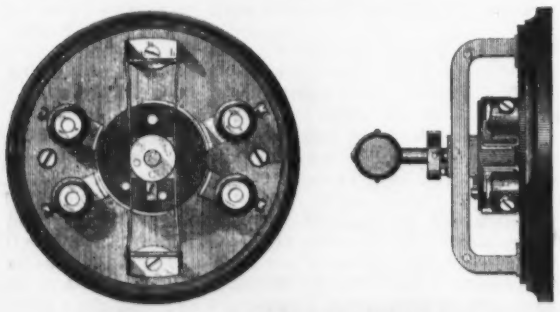
435,967. Electric Lamp; Wm. D. Graves, Cleveland, O., Assignor of one-half to Frank J. Stafford, of same place. Application filed April 30, 1890. The invention consists in providing a duplex or multiplex arc lamp with a combination of double sets of solenoids, one solenoid in each set being of low resistance, carbon holders and carbons connected in series with said low resistance solenoids, a suitable lever and feed mechanism, and a switch arm attached to the lever to secure the successive burning of one set of carbons after the first set has been consumed.

435,982. Regulator for Dynamo-Electric Machines; William Stanley, Jr., Great Barrington, Mass. Application filed Oct. 17, 1888. The purpose of this invention is to prevent shifting of the line of commutation by the change in load, at the same time maintaining constant difference in potential. The method employed is to join the pole pieces of the generator by iron plates or bridges, thus providing a magnetic shunt between the pole pieces; around this shunt, parallel to the shaft of the generator, a coil is wound, which is connected in series with the armature coil; the flow of current through it opposes the passage of lines of force between the pole pieces through the magnetic shunt before they pass through the armature determining their direction.

435,983. Electrical Traction Apparatus; William Stephens, of Santa Rosa, Cal. Application filed March 21, 1890. The invention consists of an electrical traction machine provided with a motor so arranged that it is caused to travel from end to end of the field the current being transmitted to it through flexible conductors which are coiled and uncoiled as desired from an apparatus movable at right angles to the direction in which the traction apparatus moves.

435,985. Rheostat; Frank Thorne, Oscaloosa, Ia. Assignor to the Hawkeye Electric Manufacturing Company, of Davenport, Ia. Application filed Aug. 1, 1888. The invention consists of a cylindrical metallic case lined with asbestos and filled with an infusible, non-combustible, high resistance powder. A movable contact in the form of a screw is attached to a spindle which is threaded through one head of the cylinder; this spindle forms one electrode, the opposite one being placed at the bottom of the cylinder.

436,001. Electrolyte for Galvanic Batteries; Frank K. Irving and Frederick M. Hill, of Brooklyn, N. Y. Application filed Jan. 3, 1890. The electrolyte described consists of sulphuric acid, chromic acid and nitrate of peroxide of iron. The resulting



No. 436,087.—ELECTRIC CUT-OUT.

battery fluid gives a high voltage and does not evolve nitrous fumes, as these are oxidized as fast as produced. The battery is therefore odorless.

436,025. Electric Signal for Railways; George Armes Tower, Richmond, Va. Application filed June 11, 1889. The intent of the invention is to provide a signal for use upon railways at dangerous places, such as crossings, steep grades, bridges and the like. The signal is operated by circuit closers arranged on the side of the track and actuated by passing trains. The claims are constructional.

436,030 Electric Burglar or Automatic Fire Alarm; Edmund R. Wilder, Kansas City, Mo. Application filed Nov. 29, 1889. The apparatus described is of the closed circuit description, adapted to operate from a central station, to which signals are sent by local house batteries in case connections are interfered with by accident or design.

436,050. Secondary Battery Plate; Thomas P. Whittier, Saginaw, Mich. Application filed May 24, 1890. In this invention the plates are formed of lead or other suitable wire, intermeshed or interwoven in such a manner as to afford free opportunity to the component parts for contraction or expansion without buckling; at the same time forming a series of tubes or boxes in which the active material can be placed so as to be held securely.

436,080. Reciprocating Snap Switch; Jacob S. Gibbs, of Manchester, and Charles G. Perkins, of Hartford, Conn. Application filed March 3, 1890. The switch is provided with a reciprocating contact plug and circuit terminals, having spring contact with each other in one of the extreme positions of the plug, in combination with a separate spring tending to throw the plug out of contact with the circuit terminals, the spring having a throw considerably shorter than the limited movement of the plug.

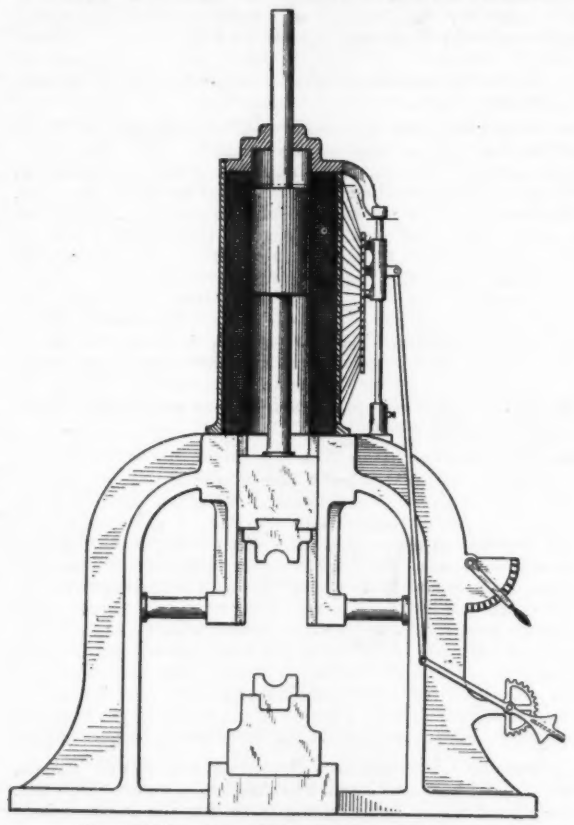
436,087. Cut-Out for Electrical Translating Devices; Charles G. Perkins, Hartford, Conn. Application filed Nov. 27, 1886. The patent is for a switch to give instantaneous make and break. The means employed consist of a rotating spindle, a contact collar loosely mounted upon it, and a ring fixed to this latter in combination with an intermediate loose tripping block. The tripping block engages pins on the movable sleeves, and is actuated by a spring.

436,107. Electric Switch; Charles G. Perkins, of Hartford, Conn. Application filed Oct. 30, 1889. The operating shaft of the switch carries an insulating block to the opposite sides of which are attached two contact strips pressed outward by springs against binding posts. To this shaft is also attached a loosely-fitting diamond-shaped metallic block. Against the opposite flat sides of this block press two long parallel springs, carried upon the base of the switch, which serve to produce a quick "make and break" movement of the contact points when the shaft and the diamond-shaped block are turned through an angle of 90 degrees.

436,113. Magneto-Electric Machines; Lamotte C. Atwood, St. Louis, Mo. Application filed May 17, 1890. The subject of this patent is in regulation of dynamo electric machines with the purpose of preventing the shifting of the line of commutation. The means employed consists in influencing the magnetic field in the line of commutation by magnetic bars so placed in the field as to effect the desired result.

436,119. Electric Soldering Iron; Charles E. Carpenter, of Minneapolis, Minn. Assignor to the Carpenter-Nevins Electro-Heating Company, of same place. Application filed June 21, 1890. The invention consists in the application of the electric method of heating to "hatchet irons," principally used in the making of cans. Iron coils separated from each other and from the metal sides of the tool by asbestos paper are placed in the interior of the hatchet-shaped implement, the wearing parts of which are removable and interchangeable.

436,120. Insulator Bracket; H. Eugene Chubbuck, Springfield, Ill. Application filed Nov. 4, 1889. The bracket is specially intended for carrying insulators of glass and other fragile material, and its essential feature is a screw threaded projecting arm



No. 436,277.—ELECTRIC POWER HAMMER.

adapted to receive the threads upon the insulator, but made of a springing material and furnished with a wide slot so as to adapt itself to variations in size of insulator screw.

436,122. Double Pole Snap Switch; Howard H. Crowell, Syracuse, N. Y. Application filed May 22d, 1890. The invention has for its object the production of a cheap and durable double pole switch; the claims are constructional, the first one being as follows: "A double pole electric switch consisting of an insulated base and provided with a series of inclines upon its upper side, all extending in the same direction; said inclines being alternately insulated and alternately provided with conducting plates secured to the upper faces of the said inclines, binding posts having wires connected thereto and to the said conducting plates, a vertical spindle having a sleeve enclosing its lower end and secured loosely in the said base by binding posts through the spool and sleeve and extending beyond its edge; a recess in the end of said spindle and spool; a coil spring secured to the lower end of said sleeve, and an insulated cross bar secured to the upper end of said sleeve, and having bifurcated brushes secured to either end."

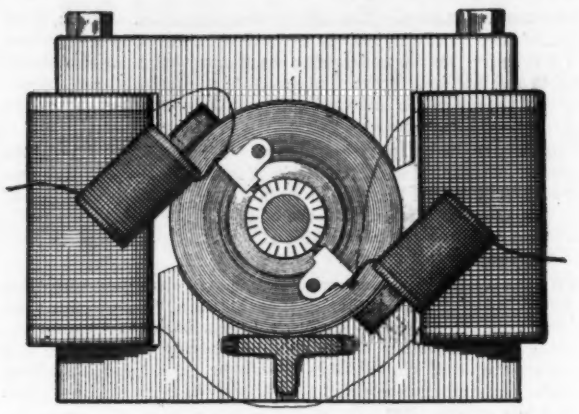
436,125. Electric Lighting and Lighting Apparatus for Electric Railway; Mark W. Dewey, Syracuse, N. Y. Application filed March 14, 1890. The invention is intended to obviate the difficulties now met in lighting electric cars, and furnishes a means of running lights in parallel instead of in series, so that the breaking of a lamp will not completely darken the car. The method employed consists of a commutator actuated by a suitable motor and furnishing pulsating currents from the ordinary source of supply to converters, which feed the lighting or heating devices in parallel arc.

436,127. Electric Motor; Thomas A. Edison, Llewellyn Park, N. J. Application made May 24, 1890. The apparatus described in this patent is directly applicable to the propulsion of moving vehicles and its intent is to secure a ready means of varying the speed and power of motors employed for such purposes. It consists essentially of two electric motors whose armatures engage the single epicyclic gear attached to the axle driven; the speed of the driven axle then depends on the relative velocity of the two armatures. If they revolve in opposite directions with equal speed there will be no rotary effort on the shaft. Should the balance then existing between the two motors be distributed by varying the field in one or both of them, the shaft will be actuated by the power depending on the changes made in the motor circuits. Under certain conditions one of the motors will be acting as a dynamo during part of time, thus saving a considerable amount of power.

436,148. Steam Dynamo-Electric Machine; Edward C. Newton, Little Rock, Ark. Application filed Oct. 30, 1889. This is the combination of a reciprocating steam engine provided with two connecting rods, with a dynamo-electric machine, whose field magnets and armature are adapted to rotating in opposite directions, and are connected respectively with the two connecting rods.

436,154. Electric Signal for Railroads; Frank C. Schroen, Baltimore, Md. Application filed May 13, 1890. The object of this invention is to automatically sound an alarm on a locomotive when two trains occupy two sections or blocks, and to maintain electrical communication between these locomotives or trains. The block signal apparatus is operated by batteries placed upon the engine.

436,168. Electric Danger and Safety Signal for Railroads; Edward Milton Burt, Paris, Ill. Application filed March 29, 1890. The present device covers the combination with the ordinary track, of signal rails arranged on either side of it, connections attached to the signal rails, a switch track, a bar attached to this, contact points attached to the bar, and adapted to form a



No. 436,113.—MAGNETO-ELECTRIC MACHINE.

contact with connections on the signal rails in the fields connected in the circuit.

436,200. Electric Converter; George Westinghouse, Jr., of Pittsburgh, Pa. Application filed Jan. 11, 1887. The converter is cylindrical in form and of such size that it may conveniently be placed inside of a lamp post. The core is built up of soft iron plates circular in form with two rectangular openings stamped out for receiving the primary and secondary coils, the metal about each opening being cut away to facilitate the insertion of the coils. The core and coils are afterwards surrounded by a close-fitting cylindrical case of soft iron.

436,205. Watch Demagnetizer; Charles F. Berlin, of New York, N. Y., Assignor to Alfred C. Smith, of same place. Application filed Jan. 15, 1890. This apparatus consists of a demagnetizing chamber, a coil of wire surrounding it, a battery or other source of electric current, a rotary rheotrope combined with four brushes, two of which are connected with the demagnetizing coil, and two with the battery, the rheotrope when revolved, causing the current from the battery to pass alternately in opposite directions through the coil.

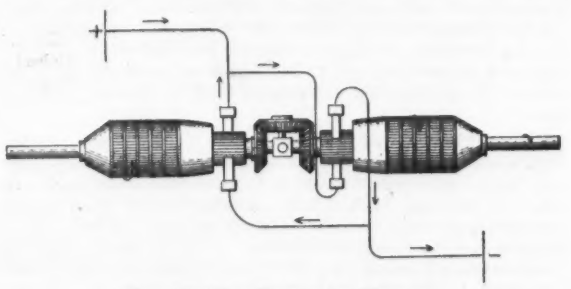
436,219. Electric Valve Controller; Harry Watson Deeds, of Indianapolis, Ind. Application filed March 20, 1890. A thermostat placed in the apartment, the temperature of which is to be regulated, acts so as to close the circuit from a battery through an electromagnet, which when energized, may attract a hinged armature valve and allow an escape of steam, thus equalizing the pressure upon the mercury in a bent mercurial gauge, one end of which opens into the escape pipe and the other into the interior of the steam chamber. This movement of the mercury, by means of suitable electrodes, reverses the current in the electromagnet and closes the valve.

436,238. Lightning Arrester; George D. Pope, Jackson, O. Application filed July 7, 1890. This lightning arrester consists of toothed discs connected by fusible strips to the line wires and rest in circular apertures in an insulated strip of metal which is connected to earth. The saw teeth of the discs give a number of discharge points, and the circular apertures are so small as to make the passage of the discharge to earth very easy.

436,275. Pulsating Current Battery System; Charles J. Van Depoele, Lynn, Mass. Application filed April 9, 1890. The invention consists of obtaining and distributing pulsating currents from any convenient source of continuous currents; the object of such change being to operate reciprocating electric engines of a type now becoming somewhat frequent. The method employed to secure this result is a specially arranged commutator, operated by an electric or other motor.

436,276. Adjustable Current for Reciprocating Engine System; Charles J. Van Depoele, Lynn, Mass. Application filed April 14, 1890. This invention is similar in its general intent to the last, but differs from it principally in that the impulses sent out from the source of continuous currents, batteries in the case shown, are made to vary in strength so that, for example, each of the impulses in one direction shall be stronger by a determined amount than the impulses in the opposite direction; thus fitting the system for the operation of drills and the like.

436,277. Electric Power Hammer; Charles J. Van Depoele, Lynn, Mass. Application filed May 23, 1890. The power hammer herein described is of the reciprocating type, in which the part delivering the blow is connected directly with the reciprocating piston by which the power is imparted. This piston is of magnetic material, and moves within a vertically arranged series of coils, connected in series and provided with individual



No. 436,127.—ELECTRIC MOTOR.

contacts. The apparatus is arranged substantially as a steam power hammer.

436,281. Portelectric; John T. Williams, Mount Vernon, N. Y. Application filed April 12, 1889. The invention is a modification of the portelectric system heretofore known, and its distinguishing feature is that the actuating coils which draw the car along are on the car instead of distributed along the track. In other words, the electromagnet is upon the car and furnished with current by suitable means, while the armatures, of tubular form, are distributed along the track.

436,316. Electric Incandescent Lamp; John S. Potter, of Newton; David J. Cartwright, of Boston, and Benjamin B. Keyes, of Chelsea, Mass. Application filed July 5, 1890. The invention consists in a combination with the socket or holder of the lamp, of a cylindrical shell of sheet metal, secured to a recess in the socket and provided with an internal screw thread which adapts it to receive the metallic cap on the base of the lamp. The arrangement employed permits lamps all of different form of cap to be used with the same socket.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.